2.5L 4-CYL - VIN [H]

1988 Jeep Cherokee

1988 CHRYSLER MOTORS ENGINES
2.5L 4-Cylinder

Jeep: Cherokee, Comanche, Wagoneer, Wrangler

ENGINE CODING

ENGINE IDENTIFICATION

NOTE: For engine repair procedures not covered in this article, see ENGINE OVERHAUL PROCEDURES - GENERAL INFORMATION article in the GENERAL INFORMATION section.

The Vehicle Identification Number (VIN) is located on the upper left side of dash, visible through windshield. The fourth character of the VIN identifies the engine size. The tenth character identifies the model year.

ENGINE IDENTIFICATION CODES TABLE

Application	VIN Code
2.5L 4-Cylinder TBI	H

SPECIAL ENGINE MARKS

Some engines are produced at the factory with oversize or undersize components. These engines are identified by a letter code stamped between ignition coil and distributor. Letters are decoded as follows:

* "B" indicates all cylinder bores .010" (.25 mm) oversize.
* "C" indicates all camshaft bearing bores .010" (.25 mm) oversize.
* "M" indicates all main bearing journals .010" (.25 mm) undersize.
* "P" indicates all connecting rod journals .010" (.25 mm) undersize.

REMOVAL & INSTALLATION

ENGINE REMOVAL

See ENGINE REMOVAL article.

INTAKE & EXHAUST MANIFOLDS

NOTE: Throttle body removal is necessary prior to manifold removal. Throttle body can be separated from the manifold and secured in a designated area with vacuum hoses attached.

Removal

1) Disconnect negative battery cable. Remove air cleaner, EGR pipe and PCV hose. Disconnect and mark all vacuum hoses and electrical connections. Drain cooling system.

2) Remove coolant hoses from intake manifold. Remove A/C compressor and power steering pump and mounting bracket (if equipped).

Disconnect throttle valve linkage on A/T models.

3) Remove coolant temperature sensor wire. Disconnect throttle cable at bellcrank. Remove intake manifold bolts. Remove intake manifold.

4) If exhaust manifold requires removal, raise and support vehicle. Disconnect exhaust pipe. Remove oxygen sensor wire and remove sensor. Remove manifold-to-cylinder head bolts. Remove exhaust manifold.

Installation

1) Ensure all gasket surfaces are clean. Install manifolds and gasket on cylinder head. Start all bolts and finger tighten. Tighten bolts in proper sequence. See Fig. 1. Tighten bolts to specification. See TORQUE SPECIFICATIONS table.

2) Clean oxygen sensor threads. Apply anti-seize on oxygen sensor threads prior to installation. Install sensor and tighten to specification. Reverse removal procedures to complete installation. Fill and purge cooling system. See COOLING SYSTEM AIR PURGE under ENGINE COOLING.

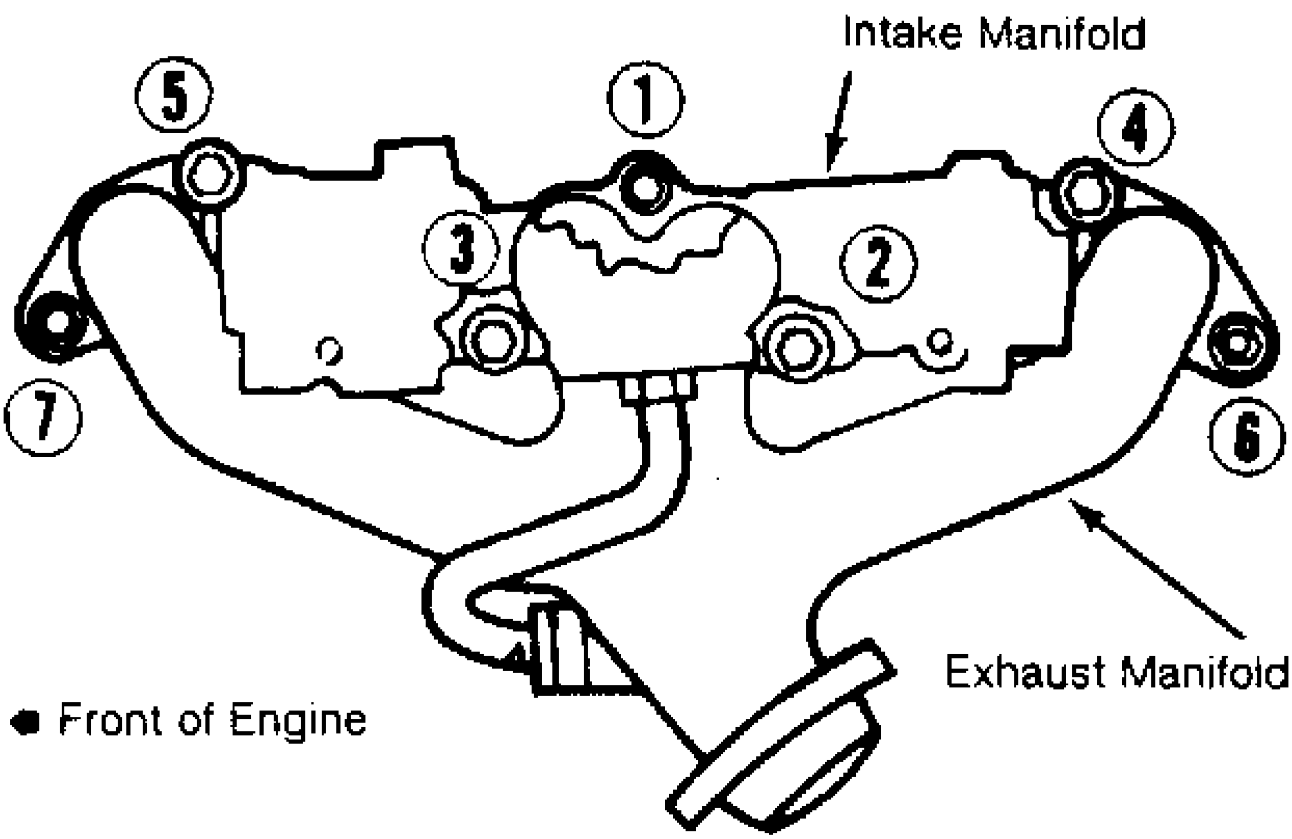


Fig. 1: Manifold Bolt Tightening Sequence

CYLINDER HEAD

Removal

1) Disconnect negative battery cable. Drain cooling system. Remove air cleaner. Remove intake and exhaust manifolds. See INTAKE & EXHAUST MANIFOLDS.

2) Disconnect and mark all hoses and electrical connections at cylinder head. Disconnect and mark spark plug wires. Remove spark plugs. Remove valve cover bolts.

3) Remove rocker arms and push rods. See ROCKER ARMS & BRIDGE under VALVES. Remove cylinder head bolts. Remove cylinder head.

Inspection

Inspect cylinder head for cracks or damage. Using straightedge, check cylinder head for warpage in several areas. Repair or replace cylinder head if warpage exceeds .002" (.05 mm) per each 6" (152 mm) or damage exists.

Installation

1) Ensure all gasket surfaces are clean. Clean carbon from combustion chambers and tops of pistons. Apply sealant to both sides of new cylinder head gasket. Install new gasket with the word "TOP" upward. Ensure all holes are aligned.

2) Install cylinder head. Apply sealing compound to threads of cylinder head bolt No. 8 prior to installation. See Fig. 2. Install head bolts. Tighten all bolts in sequence (except No. 8) to 110 ft. lbs. (149 N.m). Tighten No. 8 head bolt to 100 ft. lbs. (136 N.m). See Fig. 2.

3) Reverse removal procedures for remaining components. When installing valve cover, use RTV sealant between cover and head. Tighten bolts to specification.

4) Fill cooling system with temperature sending unit removed. Allow trapped air to escape, then install sending unit. Refill and purge cooling system. See COOLING SYSTEM AIR PURGE under ENGINE COOLING.

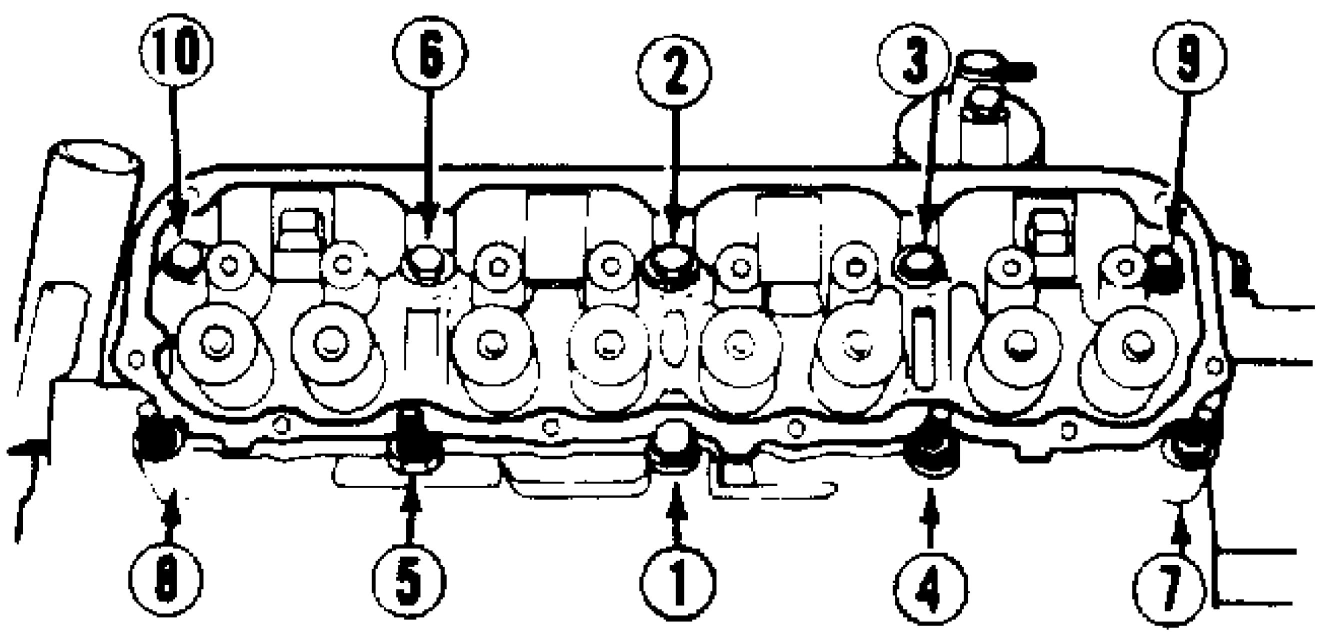


Fig. 2: Cylinder Head Bolt Tightening Sequence

VALVES

Valve Arrangement

E-I-I-E-E-I-I-E (Front-to-rear).

Valve Guides

Valve guides are not replaceable. If clearance is excessive, valve guides must be reamed to accommodate oversized stem valves.

ROCKER ARMS & BRIDGE

Removal

1) Remove PCV valve hose at valve cover. Remove valve cover bolts. Using a razor knife, cut RTV sealant along valve cover. Pry upward on valve cover in areas marked "PRY HERE" near bolt hole areas.

2) Remove valve cover. Alternately loosen each rocker arm bolt one turn at a time. Remove rocker arm assemblies and push rods. Mark components for reassembly. Components must be installed in original location.

Installation

Reverse removal procedures. Install rocker arm components in original location. Tighten bolts to specification. Apply RTV sealant on valve cover prior to installation.

VALVE SPRINGS

Valve springs can be removed without removing cylinder head.

Valve Spring Installed Height

Information not available from manufacturer.

HYDRAULIC VALVE LIFTERS

Removal

Remove rocker arms and push rods. See ROCKER ARMS & BRIDGE. Using Lifter Remover/Installer (J-21884), remove lifter through push rod openings of cylinder head. Mark lifter location for reassembly reference. Replace lifters as an assembly if damaged. Internal components cannot be interchanged.

Inspection

Inspect lifter and camshaft mating surfaces for wear. Check cylinder block lifter bore diameter. Lifter bore diameter should be within .9055-.9065" (22.999-23.025 mm). Replace parts as necessary.

Installation

Soak lifter assembly in engine oil supplement prior to installation. Reverse removal procedures for installation. Install lifter in original location.

ENGINE FRONT COVER

Removal

1) Disconnect negative battery cable. Remove drive belts, fan and hub assembly. Remove pulley from vibration damper. Remove vibration damper retaining bolt and washer.

2) Using Puller (J-21719-01), remove vibration damper and key. Remove oil pan-to-front cover bolts. Remove cover-to-block retaining bolts. Remove front cover.

3) Cut oil pan gasket even with face of cylinder block. Remove gasket from oil pan. Pry crankshaft oil seal from cover.

Installation

1) Ensure all gasket surfaces are clean. Ensure oil slinger is installed on crankshaft. Apply sealing compound on both sides of front cover gasket. Install gasket on cylinder block. Replace front section of oil pan seal with similar section fabricated from new seal.

2) Coat seal with RTV sealant and place in position. Apply sealant to the joint area of oil pan and cylinder block. Place front cover on cylinder block. Place Front Cover Seal Installer (J-22248) in front cover seal area.

3) Install all retaining bolts. Tighten bolts to

specification. Install front cover oil seal. See FRONT COVER OIL SEAL Remove front cover seal installer.

4) Reverse removal procedures. Lubricate vibration damper retaining bolt with oil prior to installation. Tighten bolts to specification.

FRONT COVER OIL SEAL

Removal & Installation

1) Remove vibration damper. Using Seal Remover (J-9256), remove seal from front cover. Position new seal on Front Cover Seal Installer (J-22248) with lip facing outward.

2) Apply sealant to seal outer diameter. Lightly coat crankshaft with oil. Place front cover seal installer on front of crankshaft. Tap seal into front cover. Remove seal installer. Lightly coat seal contact area of vibration damper with oil.

3) Install key in crankshaft (if removed). Install vibration damper. Lubricate vibration damper bolt with oil. Install retaining bolt and washer. Tighten to specification.

CAMSHAFT & TIMING GEAR

Removal

1) Drain cooling system. Remove radiator. Remove engine front cover. See ENGINE FRONT COVER. Remove distributor. Remove fuel pump (if equipped with mechanical pump). Remove rocker arms and pushrods. See ROCKER ARMS & BRIDGE under VALVES.

2) Remove valve lifters. Mark lifters for location. Remove crankshaft oil slinger. Pull chain tensioner block toward tensioner lever to compress spring. Hold block and move tensioner lever to lock position. See Fig. 3.

3) Rotate crankshaft and align timing marks on crankshaft and camshaft gears. Remove camshaft gear retaining bolt. Remove gears and timing chain. Remove camshaft.

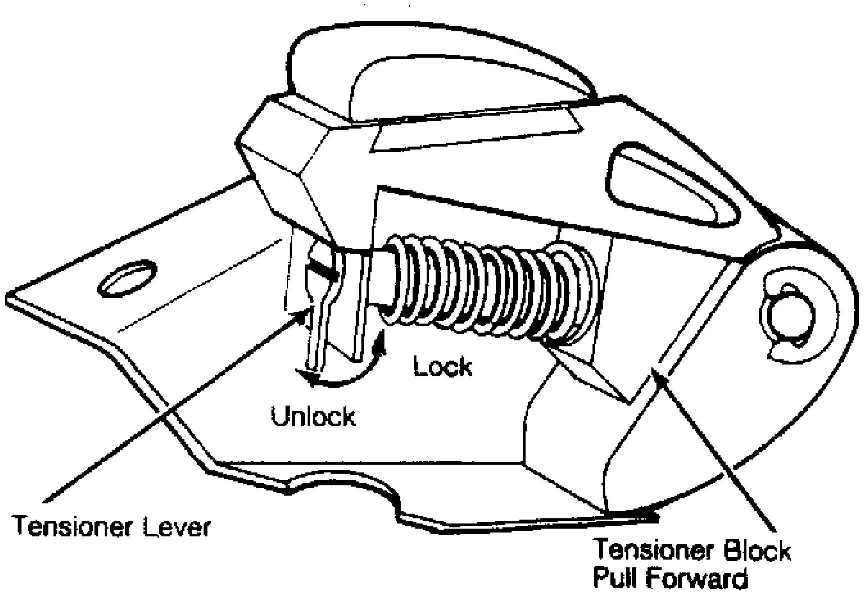


Fig. 3: Location of Chain Tensioner Lock
Courtesy of Chrysler Motors.

Inspection

Inspect camshaft for flaking, lobe wear or worn bearing

journals. Replace if not within specification. See ENGINE SPECIFICATIONS tables.

Installation

1) Lubricate camshaft and install. Avoid damage to camshaft bearings. Install timing gears and timing chain. Rotate crankshaft and camshaft so timing marks are aligned. See Fig. 4.

2) Install camshaft gear retaining bolt. Tighten to specification. Install crankshaft oil slinger. Position chain tension tensioner lever to the unlock (down) position. Reverse removal procedures to complete installation.

CAUTION: Ensure chain tensioner is released prior to front cover installation.

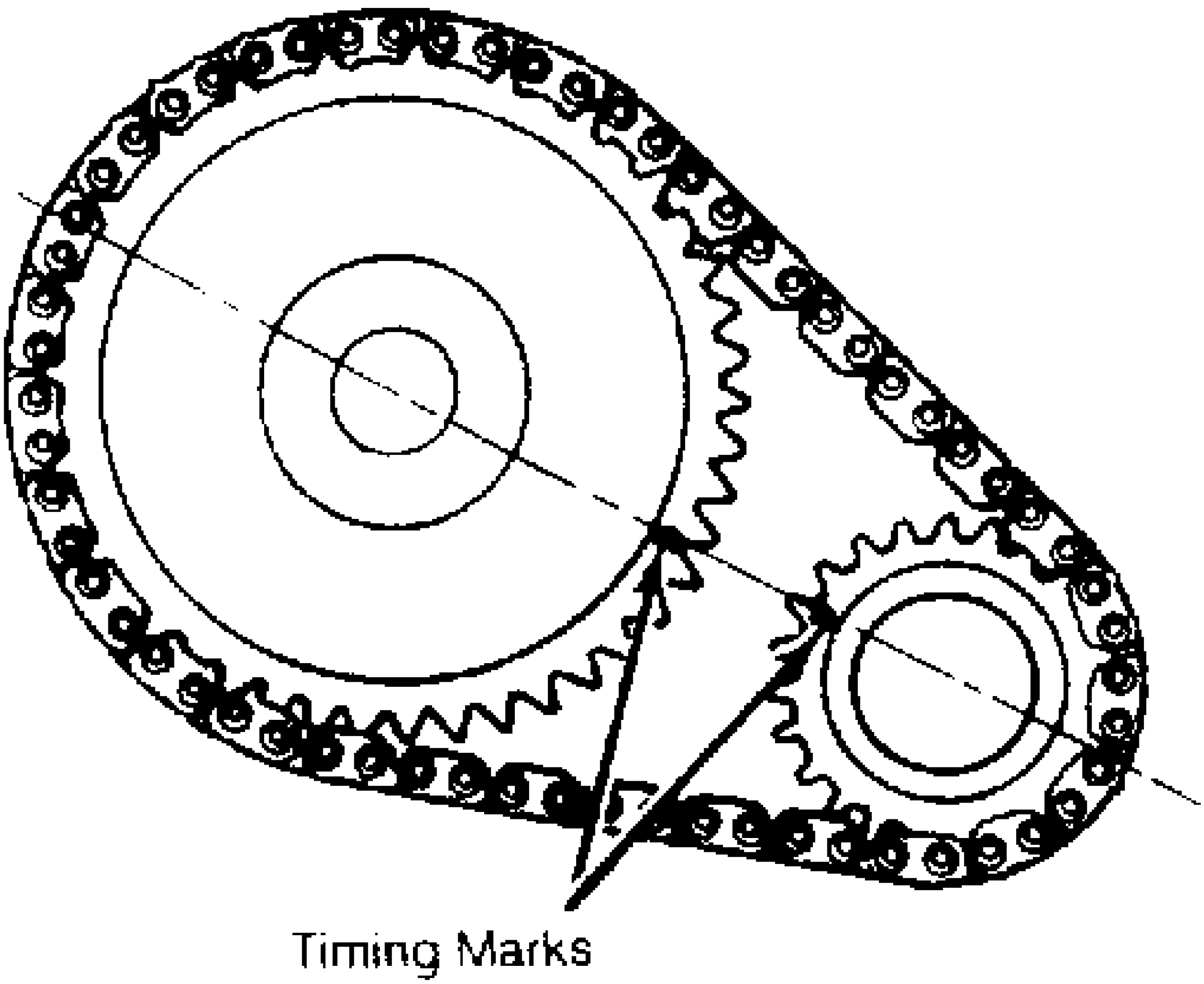


Fig. 4: Aligning Timing Marks

CAMSHAFT BEARINGS

Removal & Installation

Replace camshaft bearings using camshaft bearing remover/ installer. Ensure oil holes are aligned after installation.

OIL PAN

See OIL PAN REMOVAL article.

PISTON & ROD ASSEMBLY

NOTE: Mark piston cylinder location for reassembly reference. Install pistons in original cylinder location.

Removal

1) Remove cylinder head. See CYLINDER HEAD under MANIFOLDS & CYLINDER HEAD. Remove oil pan. See OIL PAN REMOVAL article. Remove ridge or deposits from cylinder bore.

2) Mark connecting rod and piston for cylinder ID. Remove bearing cap. Remove piston and rod assembly.

CAUTION: Arrow on top of piston must point toward front of engine. Oil squirt holes in connecting rod must face camshaft when installed.

Installation

1) Ensure ring end gap and side clearance are within specification. See ENGINE SPECIFICATIONS tables. Install rings on piston. Position ring end gaps at specified areas. See Fig. 5.

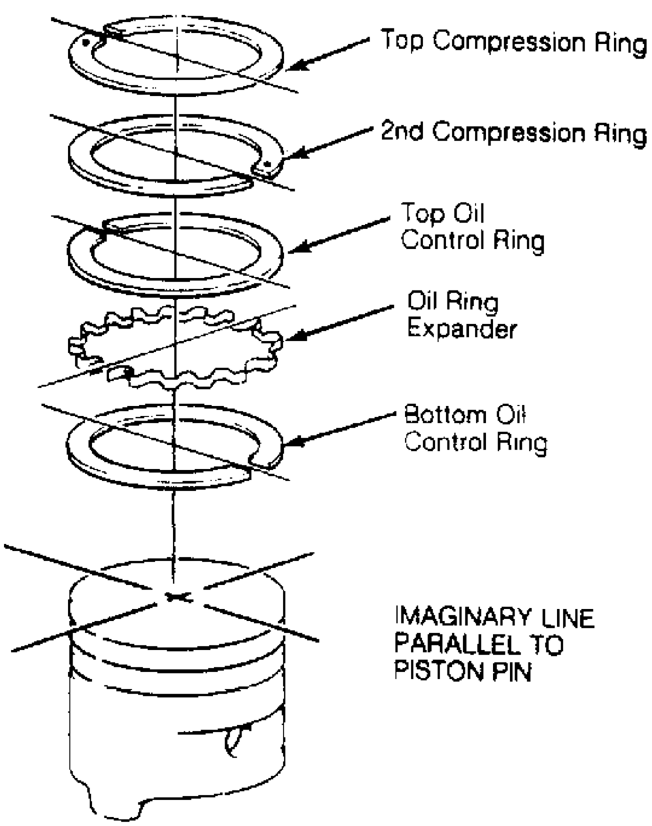


Fig. 5: Positioning Piston Ring Gaps
Ring gaps may vary 20 degrees from positions illustrated.

2) Lubricate piston assembly and cylinder block. Install piston assembly. Arrow on top of piston must face toward front of

engine and connecting rod oil squirt hole should face camshaft side of engine.

3) Install bearings. Check oil clearance and connecting rod side play clearance. Reverse removal procedures for remaining components. Tighten bolts to specification.

Fitting Pistons

1) Determine cylinder taper, wear and out-of-roundness and piston clearance. For cylinder specifications, see CYLINDER, PISTON & CONNECTING ROD SPECIFICATIONS table. If taper or out-of-roundness are not within specification, hone or bore cylinders for installation of new pistons.

2) Measure piston at right angle of the piston pin at the center line of the pin. Compare reading to cylinder bore to determine clearance. Mark fitted piston for cylinder location.

CYLINDER, PISTON & CONNECTING ROD SPECIFICATIONS TABLE

Application	In. (mm)
Connecting Rod	
Crankshaft Bore	2.2080-2.2085 (56.083-56.095)
Pin Bore	.9288-.9298 (23.591-23.616)
Cylinder Bore	
Diameter	3.8751-3.8775 (98.427-98.488)
Out-of-Round	.001 (.02)
Taper	.001 (.02)
Piston Pin Bore Diameter	.9308-.9313 (23.642-23.655)
Piston Pin Diameter	.9304-.9309 (23.632-23.644)
Piston-to-Cylinder Clearance	.0009-.0017 (.022-.043)

PISTON PIN REPLACEMENT

NOTE: Note direction of arrow on piston and oil squirt hole in connecting rod prior to removal.

Removal

Position piston on Support (J-21872-1), Pin Pilot (J-21872-2) and Driver (J-21872-3) on an arbor press. See Fig. 6. Press piston pin from piston.

NOTE: Piston and pin must be at standard room temperature when measuring fit. Piston pin should gravity-fall through the piston at room temperature. Piston pin cannot be reused after removal.

Inspection

Measure piston pin diameter, piston bore and connecting rod bores. Replace components if not within specification. See CYLINDER, PISTON & CONNECTING ROD SPECIFICATIONS table.

NOTE: Connecting rod must be positioned on the piston so the oil squirt hole faces the camshaft side of the engine with piston installed with arrow toward the front of the engine.

Installation

1) Insert pin pilot through piston and connecting rod. Place assembly on support. Insert piston pin through the upper piston pin bore and into connecting rod pin bore. See Fig. 6.

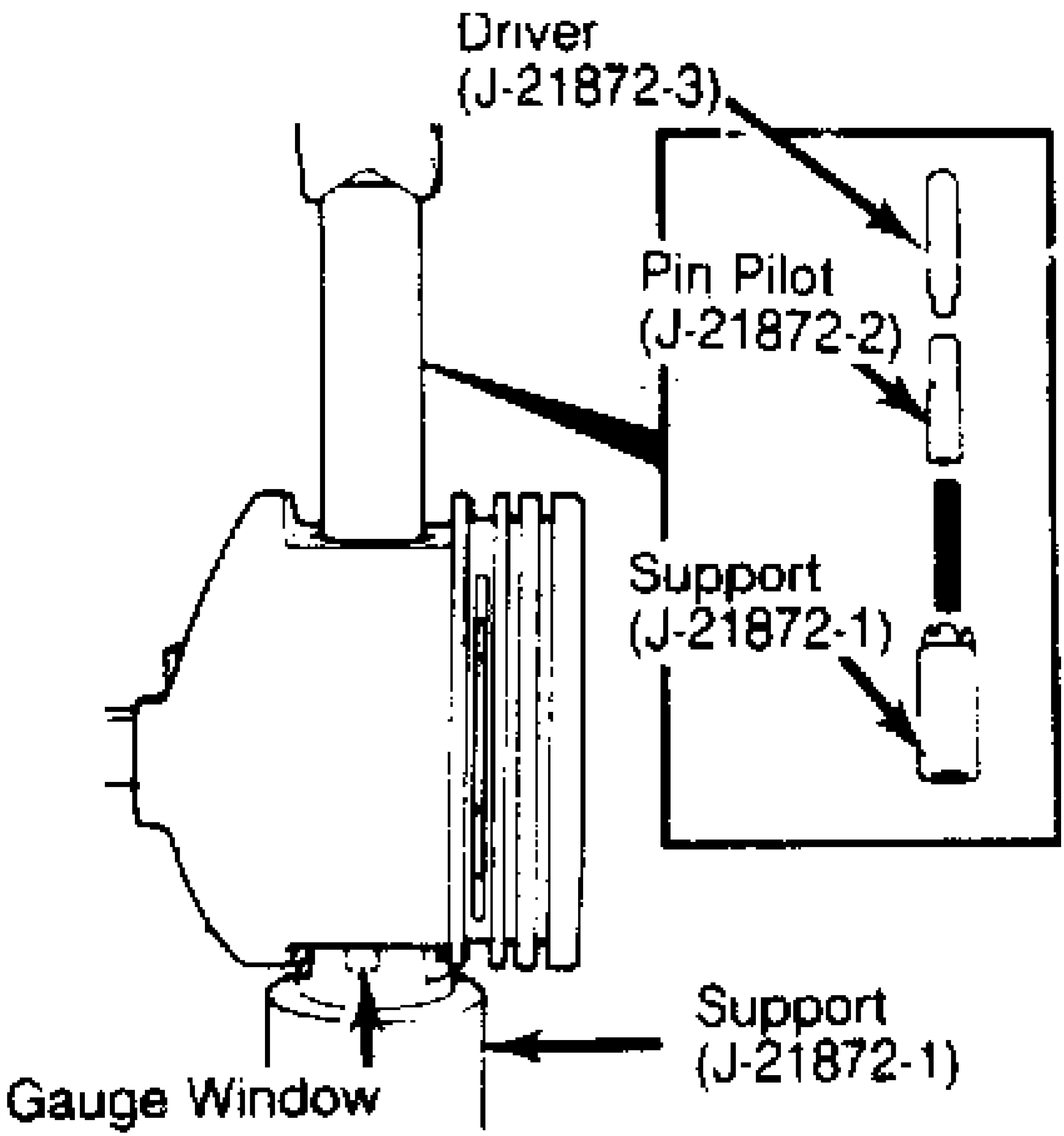


Fig. 6: Piston Pin Removal & Installation

2) Position driver inside pin. Using arbor press, press pin through rod and piston bores until pilot indexes with mark on support. Remove piston and connecting rod. Pin should be centered in rod ± .0312" (.792 mm).

3) Piston pin installation requires a 2000 lb. (906 kg) press fit. Replace connecting rod if noticeably less effort is encountered.

CONNECTING ROD BEARINGS

NOTE: Crankshaft journal diameters are indicated by a color coded mark placed on the adjacent counterweight or cheek toward the flanged (rear) end of crankshaft. Note color code to determine proper bearing usage. Check oil clearance after bearing installation.

Removal

1) Remove oil pan. See OIL PAN REMOVAL at end of ENGINE section. See oil pump. See OIL PUMP under ENGINE OILING. Remove main bearing cap.

2) Rotate crankshaft to position rod to be serviced at bottom of stroke. Mark bearing cap and connecting rod. Remove bearing cap with bearing. Push piston and rod assembly up to remove upper bearing.

Installation

1) Note color code on edge of bearings removed. Install bearings. Using Plastigage method, check bearing clearances. Replace bearings as necessary to obtain correct clearance. Bearings are available in standard and undersize application.

2) If required, different sized upper and lower bearings may be installed to obtain correct oil clearance. Tighten bolts to specification. Check rod side play. Rotate crankshaft to ensure freedom of movement. Reverse removal procedures for remaining components. Tighten bolts to specification.

NOTE: Avoid combining bearing inserts in excess of .001" (.02 mm) difference in size. Odd size inserts must be on bottom (rod cap) side.

MAIN BEARINGS

Removal

1) Remove oil pan. See OIL PAN REMOVAL at end of ENGINE section. Remove oil pump. See OIL PUMP under ENGINE OILING.

2) Ensure main bearing caps are marked for location. Rotate crankshaft to remove bearings. Note color code on edge of bearing.

NOTE: Crankshaft journal diameters are indicated by a color coded mark placed on the adjacent counterweight or cheek toward the flanged (rear) end of crankshaft. Note color code to determine proper bearing usage. Check oil clearance after bearing installation.

Installation

1) Note color code on edge of bearings removed. Install bearings. Ensure caps are installed in original location. Using Plastigage method, check bearing clearances.

2) Replace bearings as necessary to obtain correct clearance. Bearings are available in standard and undersize applications. If required, different sized upper and lower bearings may be installed to obtain correct oil clearance.

NOTE: If different sized bearings are used, the odd sized bearings must all be uniform in location (upper or lower). DO NOT use bearings with a thickness difference exceeding .001" (.02 mm).

3) Apply Loctite to corners of rear main bearing cap prior to final installation. Tighten bolts to specification. Check crankshaft end play. See CRANKSHAFT END PLAY. Rotate crankshaft to ensure freedom of movement. Reverse removal procedures for remaining components. Tighten bolts to specification.

Crankshaft End Play

1) Using dial indicator, check crankshaft end play. Inspect crankshaft thrust surfaces or thrust bearing for wear if not within specification. See ENGINE SPECIFICATIONS table.

2) Replace thrust bearing if required. When replacing thrust bearing, pry crankshaft forward then reward prior to tightening main bearing cap to specification. Recheck end play. Replace crankshaft if not within specification.

REAR MAIN BEARING OIL SEAL

Removal

Remove transmission, clutch housing and flywheel or drive plate. Using screwdriver, pry oil seal from housing. Avoid damage to surrounding area.

NOTE: Shim must be used when installing old type oil seal Part No. (324 1669) only. DO NOT use shim when installing new type oil seal Part. No. (8933 004 143).

Installation

1) Position wing nut on Seal Installer (J-36306) until it contacts the shaft nut. See Fig. 7. Install shim if old type seal Part No. (324 1669) is used.

2) Lubricate inner and outer edges of seal. Install seal on seal installer with seal dust shield toward the wing nut. Install seal installer on crankshaft so pilot and dowel are positioned on the crankshaft.

3) Thread the seal installer attaching screws into the crankshaft and tighten. Rotate wing nut until it bottoms. This will properly position the seal.

4) Remove seal installer. Ensure dust shield is not curled under. Reverse removal procedures for remaining components.

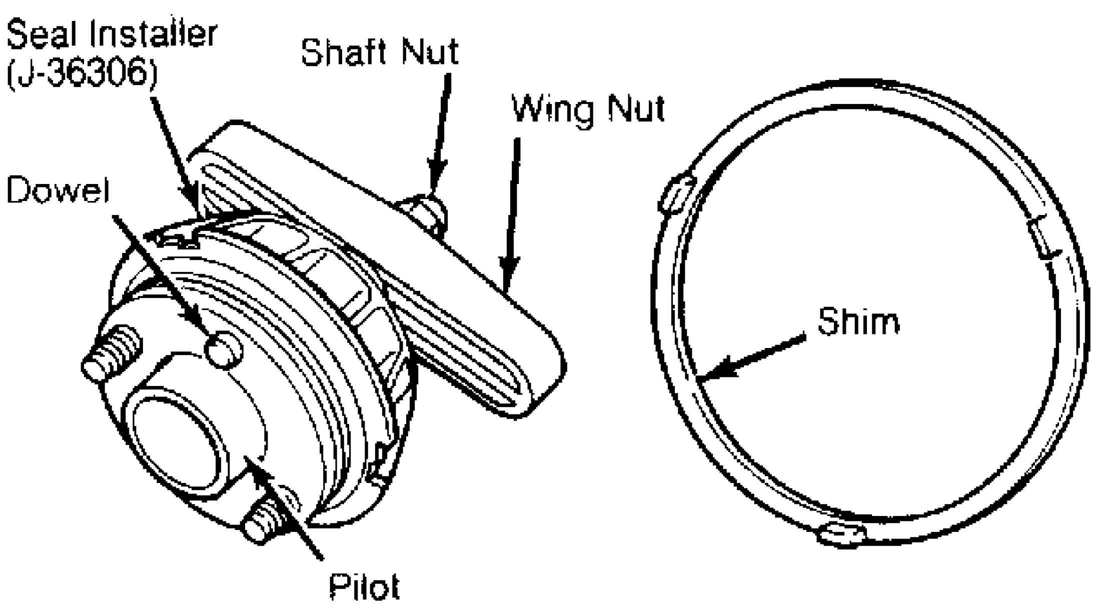


Fig. 7: Installing Rear Main Bearing Oil Seal

WATER PUMP

Removal

1) Drain cooling system. Remove fan shroud and drive belts. Remove fan assembly.

2) Disconnect heater hoses and lower radiator hose at water pump. Remove water pump retaining bolts. Remove water pump.

Installation

Clean all gasket surfaces. Install water pump. Tighten bolts to specification. Ensure pump turns freely. Reverse removal procedures. Fill and purge air from cooling system.

NOTE: It may be necessary to remove heater hose to remove trapped air if system cannot be purged using following procedures.

Cooling System Air Purge (Vehicles With Coolant Recovery)

Fill system to proper level. Place heater control to "HEAT" position and temperature control to "WARM" or "HIGH" position. Install coolant caps. Operate engine to normal operating temperature. Shut off engine and allow system to cool. Add coolant to recovery bottle. Repeat procedure to obtain correct coolant level.

Cooling System Air Purge (Vehicles Without Coolant Recovery)

Fill system to proper level. Place heater control to "HEAT" position and temperature control to "WARM" or "HIGH" position. Operate engine to normal operating temperature with radiator cap removed. Add necessary coolant and install radiator cap.

NOTE: For further information on cooling system capacities and other cooling system components, see ENGINE COOLING SYSTEMS article.

ENGINE OILING

CRANKCASE CAPACITY

Crankcase capacity is 4 qts. (3.8 L) with oil filter change.

NORMAL OIL PRESSURE

Normal oil pressure should be 13 psi (.91 kg/cm^2) at 600 RPM or 37-75 psi (2.6-5.3 kg/cm^2) at 1600 RPM.

OIL PRESSURE REGULATOR VALVE

Oil pressure regulator valve is located in oil pump body and is nonadjustable.

OILING SYSTEM

Engine lubrication is provided by the distributor driven gear-type oil pump. Oil is supplied through the full-flow oil filter and into an internal oil passage. Internal passage runs along right side of block and intersects lifter bores.

Oil is then routed to camshaft and crankshaft bearings. Oil is supplied to rocker arms from the hydraulic lifters and through the push rods. By-pass valves are located in oil filter mounting and oil pump.

OIL PUMP

Removal

Remove oil pan. See OIL PAN REMOVAL article. Remove oil pump

retaining bolts.

CAUTION: DO NOT move oil pick-up pipe in pump body. If oil pick-up pipe is moved, pick-up pipe must be replaced to ensure an airtight seal.

Disassembly & Inspection

Disassemble pump. See Fig. 8. Inspect for wear or damage. Using straightedge and feeler gauge, measure gear end clearance. See Fig. 9. Replace assembly if gear end clearance exceeds specification. Measure gear-to-body clearance. Replace components as necessary if not within specification. See OIL PUMP SPECIFICATIONS table.

CAUTION: If relief valve is replaced, ensure replacement valve is the same diameter as that removed. Different diameter valves may be used.

Reassembly & Installation

1) Reverse disassembly procedures. Apply Permatex No. 2 to pick-up pipe prior to installation. Using Pipe Installer (J-21882), install pick-up pipe. Ensure pick-up pipe support bracket is aligned with pump cover bolt.

2) Fill pump cavity with petroleum jelly prior to installing pump cover. Apply Loctite on pump cover area. Install cover and bolts. Tighten bolts to specification. Check pump gears for freedom of rotation.

3) Install oil pump and new gasket. Tighten retaining bolts to specification.

OIL PUMP SPECIFICATIONS

OIL PUMP SPECIFICATIONS TABLE

Application	In. (mm)
Gear End Clearance	.002-.006 (.05-.15)
Gear-to-Body Clearance	.002-.004 (.05-.10)

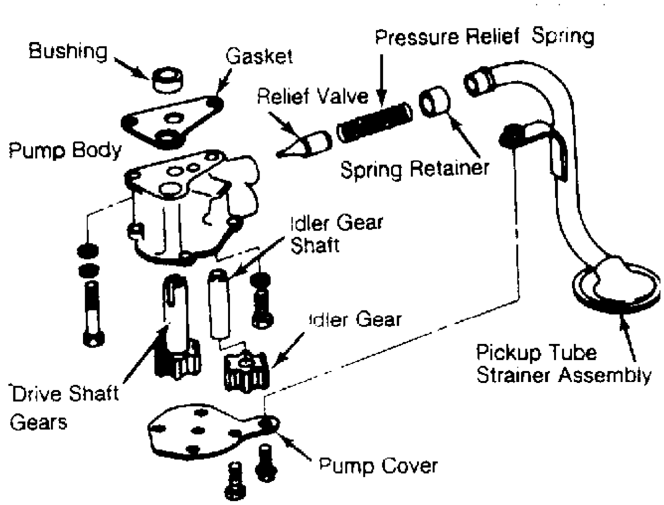


Fig. 8: Exploded View of Oil Pump Assembly

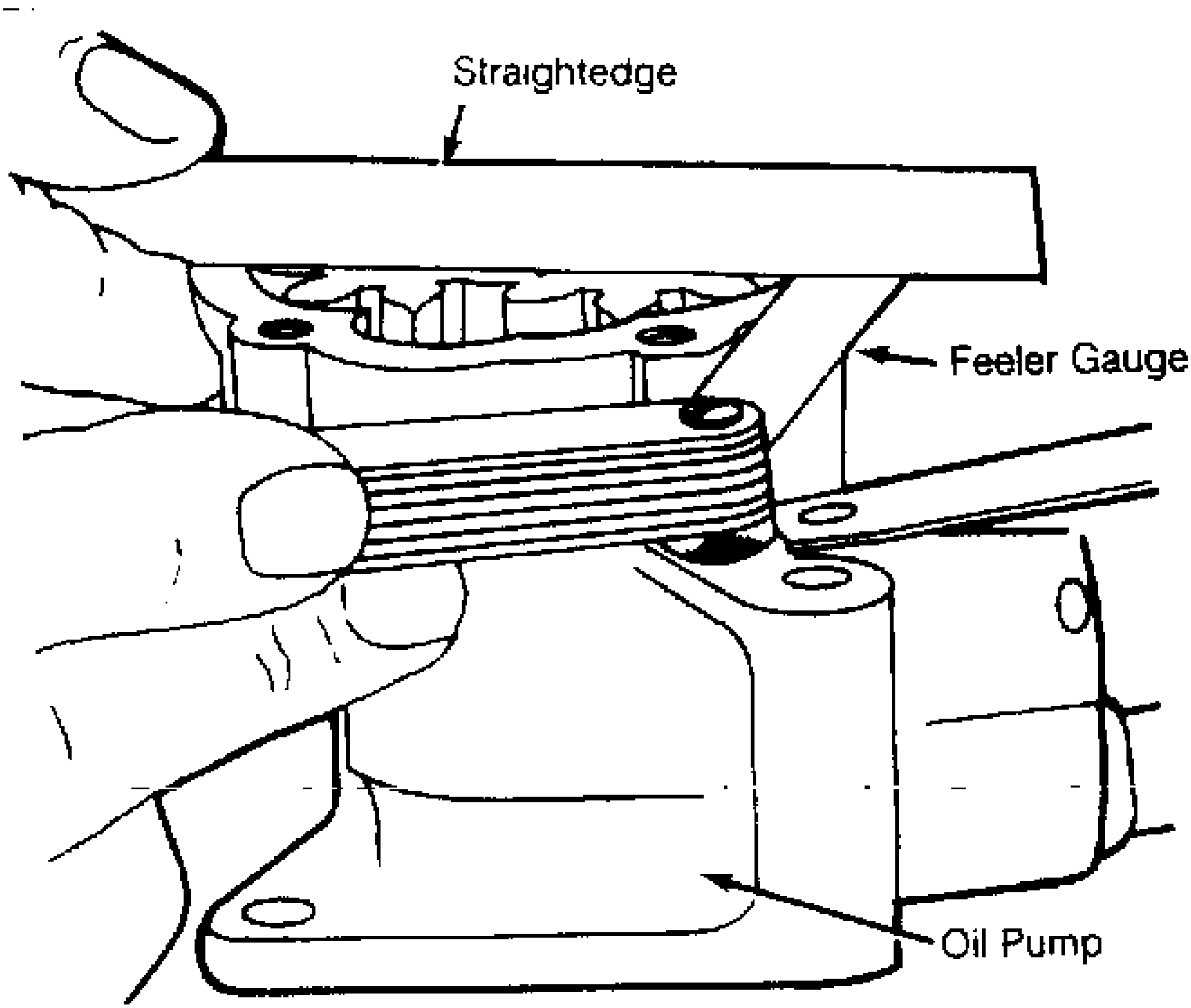


Fig. 9: Measuring Oil Pump Gear End Clearance

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS TABLE

Application	Ft. Lbs. (N.m)
Camshaft Sprocket Bolt	80 (109)
Connecting Rod Cap Nut	33 (45)
Cylinder Head Bolt	
No. 8	100 (136)
All Others	110 (149)
Drive Plate-to-Converter Bolt	22 (30)
EGR Valve Pipe Nut	30 (41)
Exhaust Manifold Bolt	23 (31)
Fan Bolt	18 (24)
Flywheel-to-Crankshaft Bolt	(1) 50 (68)
Intake Manifold Bolt	23 (31)
Main Bearing Cap Bolt	

Step 1	40 (54)
Step 2	70 (95)
Step 3	80 (109)
Oil Pump Retaining Bolt	
Short	10 (14)
Long	17 (23)
Oxygen Sensor	35 (47)
Pulley-to-Vibration Damper Bolt	20 (27)
Rocker Arm Bolt	19 (26)
Throttle Body-to-Intake Bolt	16 (22)
Torque Converter Drive Plate-to-Crankshaft Bolt	(1) 40 (54)
Vibration Damper Bolt	(2) 80 (109)
Water Pump Bolt	13 (18)
	INCH Lbs. (N.m)
Front Cover-to-Block	
Bolt	60 (7)
Stud	192 (22)
Oil Pan Bolt	
1/4" X 20	84 (9)
5/16" X 18	132 (15)
Oil Pump Cover Bolt	70 (8)
Valve Cover Bolt	55 (5)

(1) - Tighten to specification and an additional 60 degrees.
(2) - With bolt cleaned and threads lubricated with oil.

ENGINE SPECIFICATIONS

GENERAL ENGINE SPECIFICATIONS

GENERAL ENGINE SPECIFICATIONS TABLE

Application	In. (mm)
Displacement	
Cu. In.	150
Liters	2.5
Fuel System	TBI
HP @ RPM	117 @ 5000
Torque Ft. Lbs. @ RPM	135 @ 3500
Compression Ratio	9.2:1
Bore	3.88 (98.5)
Stroke	3.19 (81.0)

VALVE SPECIFICATIONS

VALVE SPECIFICATIONS TABLE

Application	In. (mm)
Intake (1)	
Head Diameter	1.905-1.915 (48.38-48.60)
Face Angle	44°
Seat Angle	44° 30'
Seat Width	(2) .040-.060 (1.02-1.52)
Stem Diameter	.311-.312 (7.89-7.98)
Stem Clearance	.001-.003 (.02-.08)
Valve Lift	.424 (10.76)

Exhaust (1)

Head Diameter	1.495-1.505 (37.97-38.60)
Face Angle	44°
Seat Angle	44° 30'
Seat Width	(2) .040-.060 (1.02-1.52)
Stem Diameter	.311-.312 (7.89-7.98)
Stem Clearance	.001-.003 (.02-.08)
Valve Lift	.424 (10.76)

(1) - Minimum valve margin is 1/32" (.78 mm).
(2) - Maximum seal runout is .0025" (.084 mm).

PISTON/PIN/RING SPECIFICATIONS

PISTONS, PINS & RINGS SPECIFICATIONS TABLE

Application	In. (mm)
Piston Clearance	.0009-.0017 (.023-.043)
Pins	
Piston Fit	.0003-.0005 (.008-.013)
Rod Fit	Press Fit
Rings	
Ring No. 1 & 2	
End Gap	.010-.020 (.25-.51)
Side Clearance	.0017-.0032 (.043-.081)
Ring No. 3	
End Gap	.010-.025 (.25-.64)
Side Clearance	.001-.008 (.03-.020)

BEARING SPECIFICATIONS

CRANKSHAFT MAIN & CONNECTING ROD BEARINGS SPECS TABLE

Application	In. (mm)
Main Bearings	
Journal Diameter	2.4996-2.5001 (63.489-63.502)
Clearance	.0010-.0025 (.02-.063)
Thrust Bearing	No. 2
Crankshaft End Play	.0015-.0065 (.038-.165)
Connecting Rod Bearings	
Journal Diameter	2.0934-2.0955 (53.172-53.225)
Clearance	.001-.003 (.02-.08)
Side Play	.010-.019 (.02-.48)

VALVE SPRING SPECIFICATIONS

VALVE SPRINGS SPECIFICATIONS TABLE

Application	In. (mm)
Free Length	1.82 (46.2)
Pressure (1)	
Valve Closed	66-74 @ 1.63 (30-34 @ 41.3)
Valve Open	205-220 @ 1.20 (91-100 @ 30.5)

(1) - Lbs. @ In. (Kg @ mm).

CAMSHAFT SPECIFICATIONS

CAMSHAFT SPECIFICATIONS TABLE

Application	In. (mm)
Clearance	.001-003 (.02-.08)
Lobe Lift	.265 (6.73)
No. 1	2.029-2.030 (51.54-51.56)
No. 2	2.019-2.020 (51.28-51.30)
No. 3	2.009-2.010 (51.03-51.05)
No. 4	1.999-2.000 (50.77-50.80)

1988 Computerized Engine Controls
JEEP 4-CYLINDER 2.5L TBI COMPUTERIZED EMISSION CONTROL

Cherokee, Comanche

DESCRIPTION

The computerized engine control system, used on 2.5L models with throttle body fuel injection, is built around an electronic control unit (ECU). The ECU is a microprocessor-based computer.

The major function of the system is to reduce emissions. It accomplishes this through a series of 13 sensors or switches that constantly monitor several engine conditions. See Fig. 16.

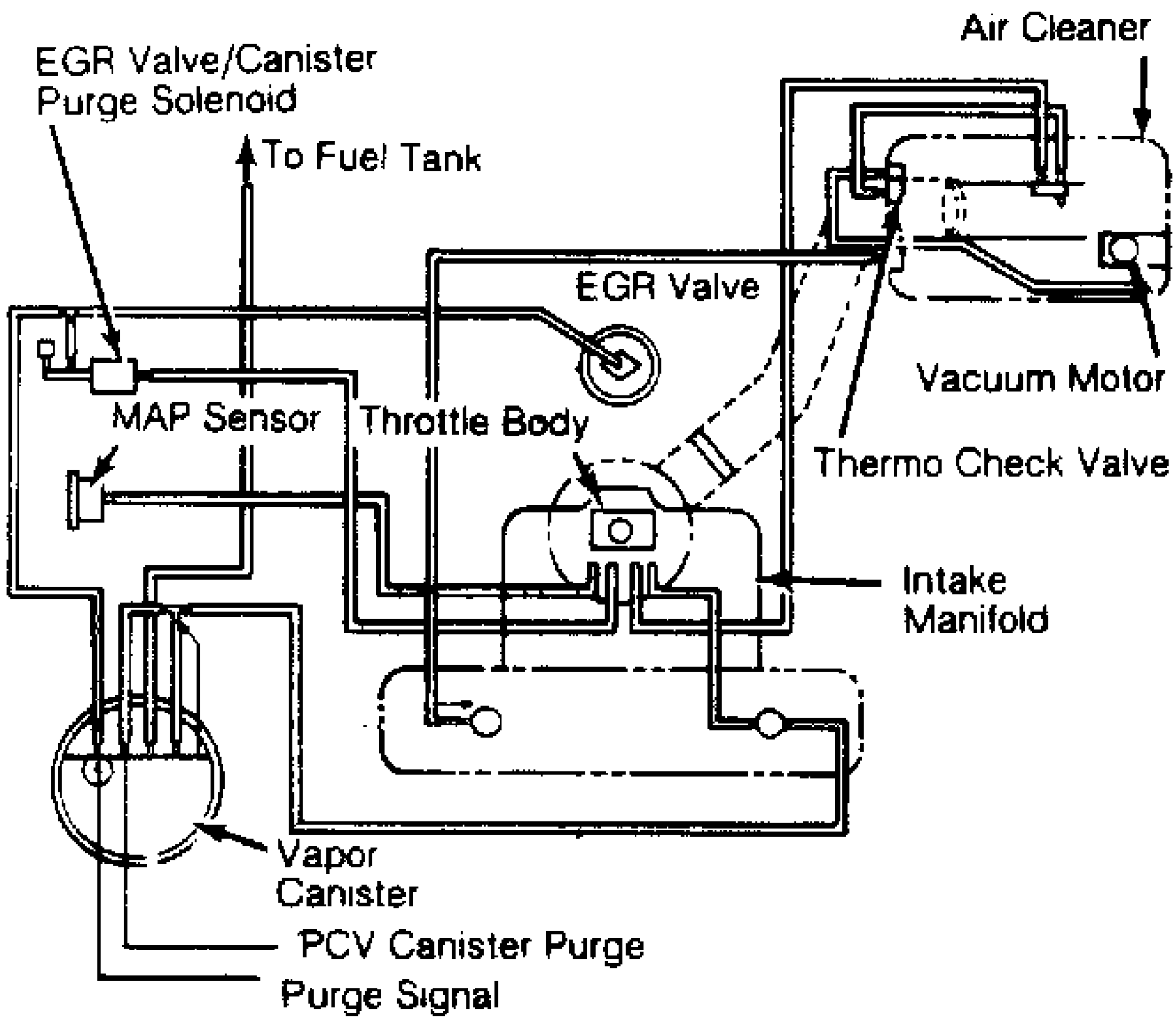


Fig. 1: Vacuum Diagram for Jeep 2.5L CEC System

The computer processes input information from the sensors to get an accurate picture of engine operation. It then provides output control signals to regulate air/fuel ratio, ignition, idle speed and

emission control devices. This permits optimum engine performance with minimum emissions.

OPERATION

The engine control system is divided into 6 sub-systems: electronic control unit (also called the ECU or computer), sensors and switches, fuel control, emission control, idle speed control, and ignition advance control.

ELECTRONIC CONTROL UNIT (ECU)

The ECU is located under the instrument panel, above the accelerator pedal. It receives information from the 13 engine sensors or switches to determine engine operating conditions at any particular moment. The ECU responds to these signals by sending a control signal to the fuel injector, fuel pump, ignition control module, idle speed actuator (ISA) motor, EGR solenoid, and canister purge solenoid. It also controls the Load Swap relay, and on Man. Trans. models, the up-shift indicator lamp.

SENSORS & SWITCHES

Exhaust Gas Oxygen (EGO) Sensor

The amount of oxygen in exhaust gases varies according to the air/fuel ratio of the intake charge. The exhaust gas oxygen sensor, located in the exhaust pipe, detects this content and transmits a low voltage signal to the ECU.

The outer surface of the sensor is exposed to exhaust gases, the inner surface to outside air. The difference in the amount of oxygen contacting the inner and outer surfaces of the sensor creates a pressure, which results in a small voltage signal. This signal, which is a measure of the unburned oxygen in the exhaust gas, is transmitted to the ECU.

If the amount of oxygen in the exhaust system is low (rich mixture), the sensor voltage signal will be high. If the mixture is lean, the oxygen sensor will generate a low voltage signal.

The sensor has a heating element that keeps the sensor at proper operating temperature during all operating modes.

Manifold Air/Fuel Temperature (MAT) Sensor

The manifold air/fuel temperature sensor is installed in the intake manifold. This sensor provides a voltage signal to the ECU representing the temperature of the air/fuel mixture in the intake manifold. The ECU compensates for air density changes during high temperature operation.

Coolant Temperature Sensor (CTS)

The coolant temperature sensor is located in the intake manifold coolant jacket. This sensor provides a voltage signal to the ECU. The ECU uses this signal to determine engine temperature. During cold engine operation, the ECU responds by enriching the air/fuel mixture delivered to the injector, compensating for fuel condensation in the intake manifold, controlling engine warm-up speed, increasing ignition advance, and inhibiting operation of the EGR system.

Manifold Absolute Pressure (MAP) Sensor

The MAP sensor detects absolute pressure in the intake manifold as well as ambient atmospheric pressure. This information is supplied to the ECU, through voltage signals, as an indication of engine load. The sensor is attached to the plenum chamber near the hood latch. A vacuum line from the throttle body supplies the sensor

with manifold pressure information.

Knock Sensor

The knock (detonation) sensor, located in the cylinder head, provides an input signal to the ECU whenever detonation occurs. The ECU then retards ignition advance to eliminate the detonation at the applicable cylinders.

Speed Sensor

The speed sensor (or crankshaft position sensor) is mounted at the flywheel/drive plate housing. The sensor detects the flywheel/ drive plate teeth as they pass during engine operation and sends an electrical signal to the ECU, which calculates engine speed.

The flywheel/drive plate has a large trigger tooth and notch located 90° and 12 small teeth before each top dead center (TDC) position. When a small tooth or notch pass the magnetic core in the sensor, the build-up and collapse of the magnetic field induces a small voltage signal in the sensor pick-up windings.

The ECU counts these signals representing the number of teeth as they pass the sensor. When a larger trigger tooth and notch pass the magnetic core, a higher voltage signal is sent to the ECU. This indicates to the ECU that a piston will be at the TDC position 12 teeth later. The ECU either advances or retards ignition timing as necessary according to sensor inputs.

Battery Voltage

Battery voltage input to the ECU ensures that proper voltage is applied to the injector. The ECU varies voltage to compensate for battery voltage fluctuations.

Starter Motor Relay

The engine starter motor relay provides an input to the ECU, indicating the starter motor is engaged.

Wide Open Throttle (WOT) Switch

The WOT switch is mounted on the side of the throttle body. The switch provides a voltage signal to the ECU under wide open throttle conditions. The ECU responds to this signal by enriching the air/fuel mixture delivered to the injector.

Closed Throttle (Idle) Switch

This switch is integral with the idle speed actuator (ISA) motor. The switch provides a voltage signal to the ECU, which increases or decreases the throttle stop angle in response to engine operating conditions.

Transmission Gear Position Indicator

The gear position indicator is mounted on vehicles equipped with automatic transaxles. It provides a signal to the ECU to indicate that the transaxle is in a driving mode and not in Park or Neutral.

Power Steering Pressure Switch

The switch increases the idle speed during periods of high power steering pump load and low engine RPM.

A/C Switch

The A/C switch sends a signal to the ECU when the air conditioner is operating and when the compressor clutch must be engaged to lower the temperature. The ECU, in turn, increases engine speed to compensate for the added load of the air conditioner.

FUEL CONTROL

An electric in-tank fuel pump supplies fuel through the fuel filter located under the right rear floor pan to the throttle body, maintaining a constant operating pressure. Fuel enters the fuel bowl reservoir of the throttle body through the injector and overflow type fuel pressure regulator. The fuel pump is controlled by the ECU. A ballast resistor attached to the right side of the plenum chamber, reduces fuel pump speed after engine is running. The resistor is by-passed in the "Start" position.

The fuel injector and fuel pressure regulator are integral components of the throttle body. The injector is electronically-controlled by the ECU. See Fig. 15.

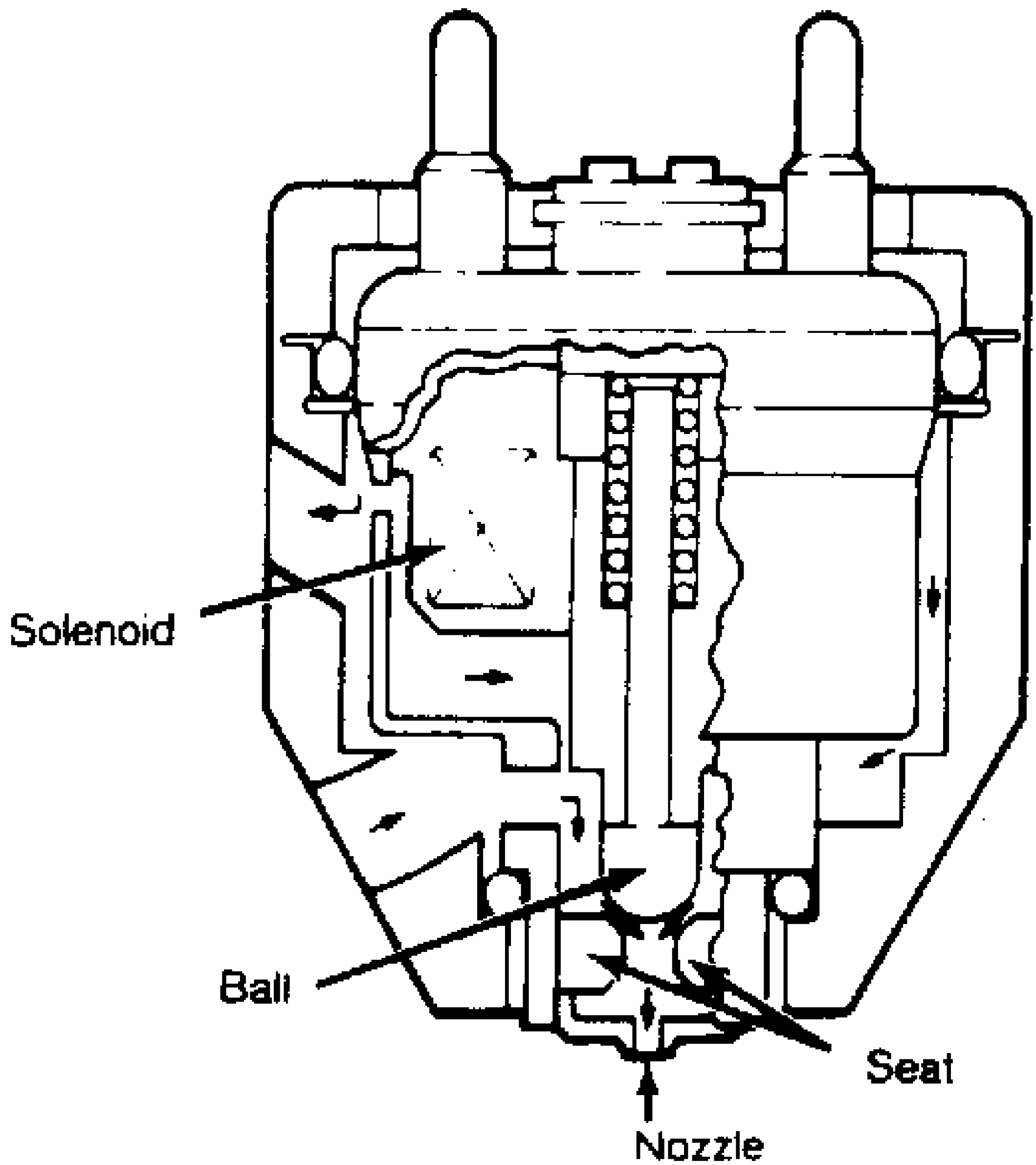


Fig. 2: Cross Section View of Injector

The fuel pressure regulator is a diaphragm-operated relief valve which maintains fuel pressure of 17.3 psi (1.2 kg/cm^2). See Fig. 16. Fuel in excess of this pressure is returned to fuel tank by a

fuel return line. The regulator is not controlled by the ECU. The regulator’s spring chamber is vented to the same pressure as the tip of the injector.

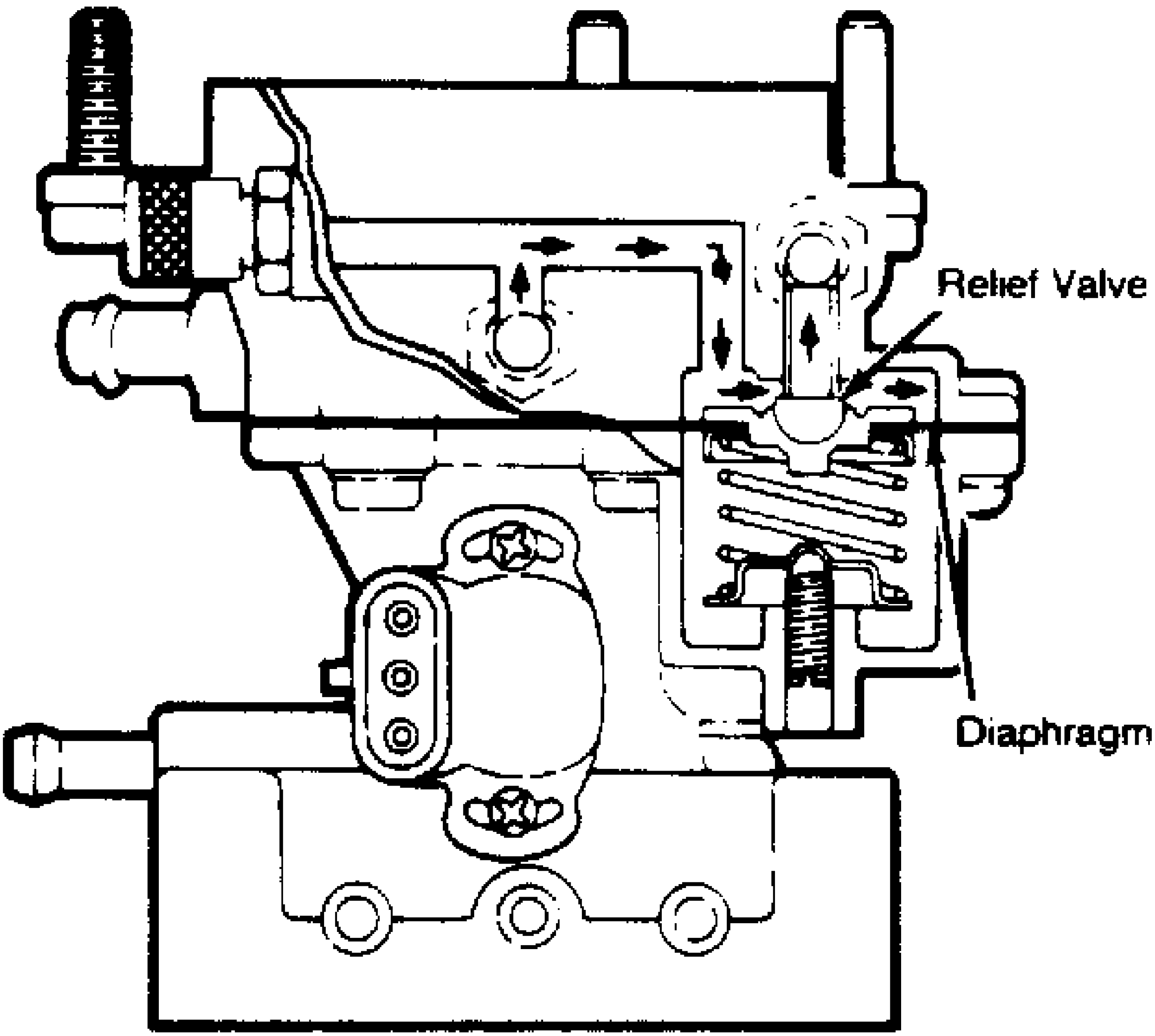


Fig. 3: Cross Section View of Fuel Pressure Regulator

Since fuel pressure at the injector is kept constant, the volume of fuel injected is dependent only on the length of time that the injector is energized. The injection time duration is based on engine operating conditions, which are provided to the ECU by the

input sensors. During engine start-up, the injector delivers an extra amount of fuel to aid in starting.

EMISSION CONTROL

Both EGR and canister purge operation are regulated by the ECU. Regulation of these 2 systems is accomplished through the use of an electrically-operated vacuum solenoid.

Whenever the solenoid is energized by the ECU, it prevents vacuum action on the EGR valve and canister. The solenoid is energized by the ECU during engine warm-up, improving cold driveability. It is also energized during closed throttle (idle), wide open throttle and during rapid acceleration or deceleration.

In this way the EGR is prevented from operating until the engine reaches a predetermined temperature. The canister purge does not operate until the oxygen sensor warms up and becomes operational. This prevents an over-rich mixture until the oxygen sensor can compensate for the extra fuel vapor.

IDLE SPEED ACTUATOR (ISA)

The ISA motor, located on the throttle body, is an electrically-driven actuator that changes the throttle stop angle by acting as a movable idle stop. The ECU commands the ISA to control engine idle speed and maintain a smooth idle during sudden engine deceleration. It does this by providing the appropriate voltage outputs to produce the idle speed or throttle stop angle required for the particular engine operating condition. There is no idle speed adjustment.

For cold engine starting, the throttle is held open for a longer period to provide adequate engine warm-up prior to normal operation. When starting a hot engine, the throttle is open for shorter time.

Under normal engine operating conditions, engine idle is maintained at a pre-programmed RPM, which may vary slightly due to engine operating conditions. Under certain engine deceleration conditions, the throttle is held slightly open.

IGNITION ADVANCE CONTROL

Under certain engine operating conditions, the predetermined ignition advance curve is modified. This is accomplished through 2 switching circuits that connect the ECU and the ignition control module.

ECU-CONTROLLED RELAYS

System Power Relay

Located on the right strut tower, this relay is energized during engine start up and remains energized until 3 to 5 seconds after the engine is stopped. This permits the ECU to extend the idle speed actuator for the next start up and then cease operation. See Fig. 4.

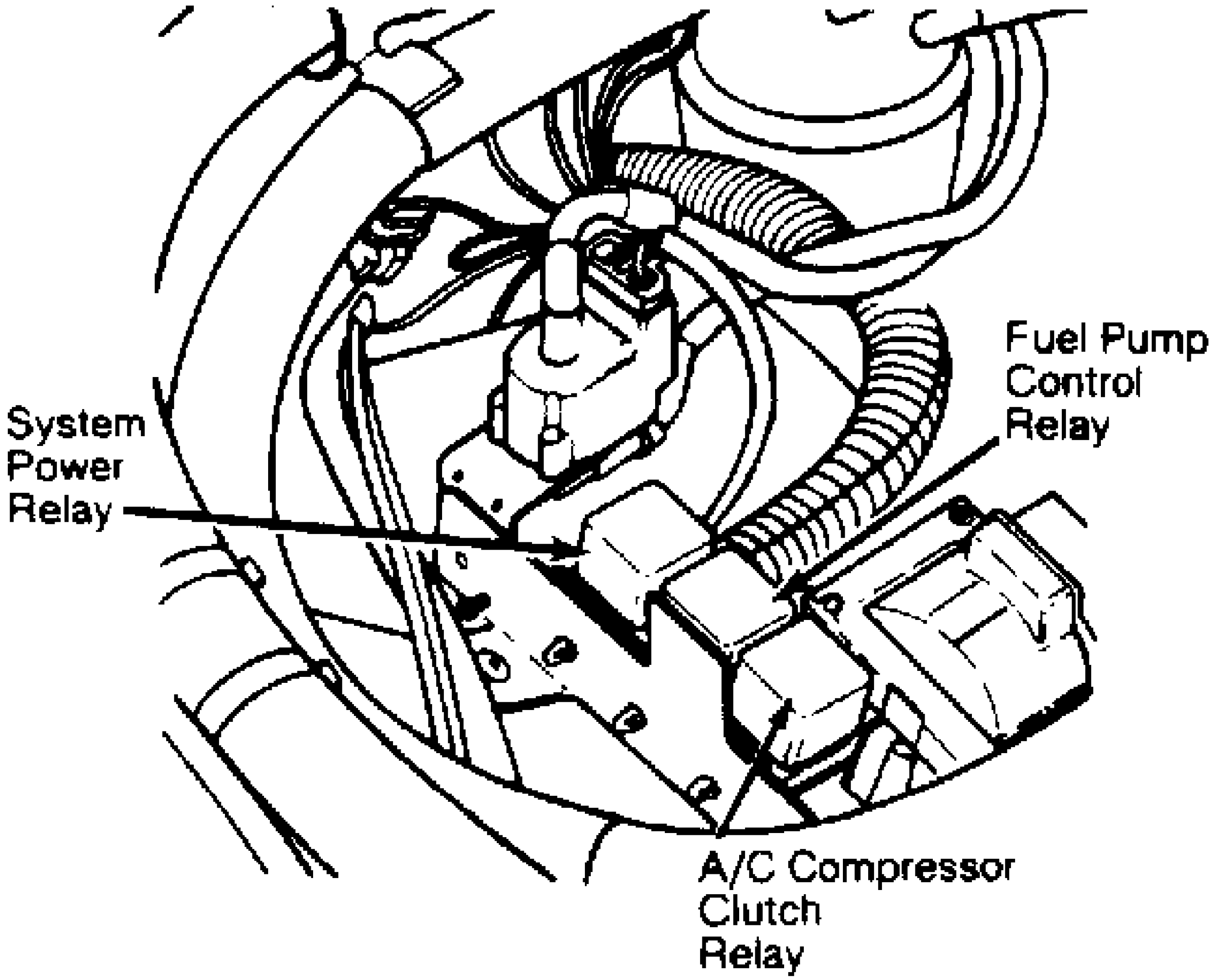


Fig. 4: Location of ECU-Controlled Relays

Load Swap Relay

The Load Swap Relay is used on models with A/C and power steering. The relay works in conjunction with the power steering pressure switch to disengage the A/C compressor clutch.

If the compressor clutch is engaged when the power steering pressure switch contacts close, the input signal from the switch to the ECU also activates the load swap relay. The relay contacts open, cutting off electrical feed to the compressor clutch. The clutch remains disengaged until the pressure switch contacts reopen and engine idle returns to normal.

NOTE: The load swap relay does not reengage the compressor clutch immediately. The relay has a timer that delays energizing the clutch for .5 second to ensure smooth engagement.

Fuel Pump Control Relay

Battery voltage is applied to the relay through the ignition switch. The relay is energized when a ground is provided by the ECU. When energized, voltage is applied to the fuel pump See Fig. 15.

A/C Clutch Relay

The ECU controls the A/C compressor clutch by means of the A/C clutch relay. See Fig. 15.

UP-SHIFT INDICATOR LAMP

Manual transaxle vehicles are equipped with an up-shift indicator lamp. The lamp is normally turned on when the ignition switch is turned "ON", and is turned off when the engine starts.

The lamp will again light during engine operation, according to engine speed and load conditions. A switch, located on the transaxle, prevents lamp from lighting when transmission is shifted to the next highest gear. If the shift of gears is not performed, the ECU will turn the lamp off after 3-5 seconds.

MODES OF OPERATION

IGNITION SWITCH "ON" MODE

When the TBI system is activated by the ignition switch, the system power relay is energized, and the fuel pump is energized by the ECU through the fuel pump relay. The pump will operate for approximately 1 second, unless the engine is operating or the starter motor is engaged.

The ECU receives input from the CTS, MAT, and MAP sensors. The up-shift indicator lamp is illuminated.

ENGINE START-UP MODE

When the starter motor is engaged, the ECU receives inputs from the CTS and speed sensors, the starter motor relay, and the wide open throttle switch. The fuel pump is activated by the ECU and voltage is applied to the injector, with the ECU controlling injection time.

The ECU determines proper ignition timing from the speed sensor input. If the wide open throttle switch is engaged, the ECU will deactivate the injector to prevent flooding.

ENGINE WARM-UP MODE

The ECU receives inputs from the CTS, MAT, MAP, speed, and knock sensors. It also is informed of throttle, gear (automatic transaxle models) and A/C control position.

The ECU provides a ground for the injector, precisely controlling fuel delivery to the engine. The ECU also controls ignition timing, engine idle speed and throttle stop angle. On vehicles with manual transmissions, the up-shift indicator lamp is controlled according to engine speed and load.

CRUISE MODE

During cruising speed, the ECU receives inputs from the CTS, MAT, MAP, EGO, speed and knock sensors. It is also informed of throttle, gear (automatic transaxle models), and A/C control position.

The ECU provides a ground to the injector, precisely controlling injector time. It also controls idle speed, throttle stop angle, ignition timing, air/fuel mixture ratio and up-shift indicator lamp.

DECELERATION MODE

During deceleration, the ECU receives inputs from the CTS,

MAT, MAP, EGO, speed and knock sensors. It also is informed of throttle, gear (automatic transaxle models) and A/C control position.

When the ECU receives deceleration input from the closed throttle (idle) switch, it grounds the EGR valve/canister purge solenoid. This interrupts vacuum to EGR valve and canister purge function. The injector is grounded, and during rapid deceleration, the ECU may stop injection for a short period of time. The ECU also controls engine idle speed and throttle stop angle.

WIDE OPEN THROTTLE MODE

During wide open throttle mode, the ECU receives inputs from the CST, MAT, MAP, EGO, speed and knock sensors. It also monitors throttle position.

When the ECU receives deceleration input from the closed throttle (idle) switch, it grounds the EGR valve/canister purge solenoid. This interrupts vacuum to EGR valve and canister purge function. The EGO sensor input is not accepted by the ECU. The injector is grounded and amount of fuel is precisely controlled.

IGNITION SWITCH "OFF" MODE

When ignition switch is turned "OFF", the ECU ceases to provide ground for the injector and all fuel injection stops. The ECU causes the idle speed actuator to fully extend for the next start up. The ECU then deactivates.

COMPONENT TESTING

NOTE: When test calls for volt-ohmmeter, use of a high impedance digital type is required.

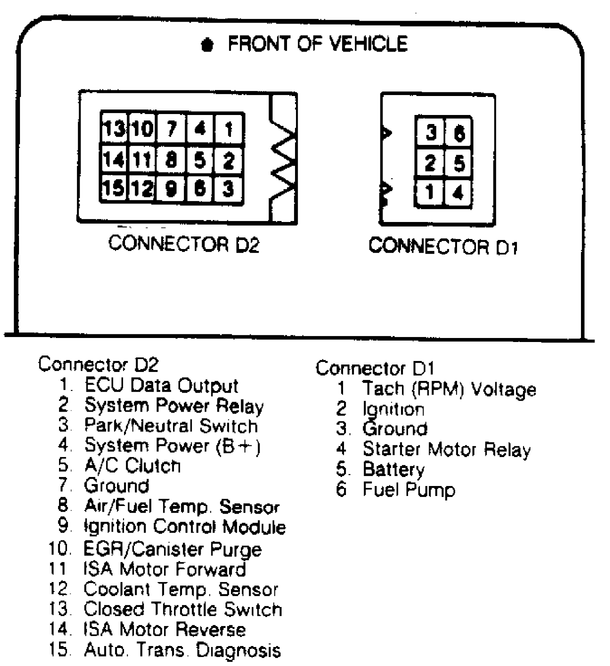


Fig. 5: Diagnostic Connectors D1 and D2 Terminal Identification

1) Disconnect wiring harness connector from the MAT sensor. Test resistance of the sensor with an ohmmeter. If resistance is not 185-100,700 ohms (3400 ohms at 70°F; 1600 ohms at 100°F), replace

sensor. With engine warm, resistance should be less than 1000 ohms.

2) Connect one ohmmeter lead to sensor connector terminal. Connect other lead, in turn, to ECU harness connector terminals 32 and 14. Repair wiring harness if resistance is greater than 1 ohm.

COOLANT TEMPERATURE SENSOR

1) Disconnect wiring harness from CTS sensor. Test resistance of sensor. If resistance is not 185-100,700 ohms (3400 ohms at 70°F; 1600 ohms at 100°F), replace sensor. With engine warm, resistance should be less than 1000 ohms.

2) Connect one ohmmeter lead to sensor connector terminal. Connect other lead, in turn to ECU harness connector terminals 15 and 32. Repair wiring harness if an open circuit is indicated.

WIDE OPEN THROTTLE (WOT) SWITCH

1) Disconnect wiring harness from WOT switch. Connect ohmmeter leads to switch terminals, and manually open and close the switch. When switch is closed, resistance should be infinite. A low resistance should be indicated at wide open position. Test switch operation several times. Replace WOT switch if defective. Reconnect wiring harness.

2) With ignition switch "ON", connect voltmeter between pin 6 and pin 7 (ground) of diagnostic connector D2. Voltage should be zero with switch in wide open position and greater than 2 volts in any other position.

3) If voltage is always zero, test for short circuit to ground in wiring harness or switch. Check for open circuit between pin 8 of ECU connector and the switch connector. Repair or replace wiring harness as necessary.

4) If voltage is always greater than 2 volts, test for an open wire or connector between the switch and ground. Repair as required.

CLOSED THROTTLE SWITCH

NOTE: It is important that all testing be done with the idle speed actuator (ISA) motor plunger in the fully extended position (as it would be after a normal engine shut down). If it is necessary to extend the motor plunger to test the switch, an ISA motor failure can be suspected. Refer to ISA motor test.

1) With ignition on, connect voltmeter positive lead to pin 13 of diagnostic connector D2. Attach negative lead to pin 7. Voltage should be close to zero at closed throttle and greater than 2 volts at any position other than closed throttle.

2) If the voltage is always zero, test for a short circuit to ground in the wiring harness or switch. Test for an open circuit between pin 25 of ECU connector and throttle switch.

3) If voltage is always more than 2 volts, test for an open circuit in the wiring harness between the ECU and switch connector. Also check for open circuit between the switch connector and ground. Repair or replace wiring harness as needed.

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR

1) Inspect MAP sensor vacuum hose connections at sensor and throttle body. Repair as required. Test MAP sensor output voltage at MAP sensor connector pin B (as marked on sensor body) with the ignition switch "ON" and engine off. See Fig. 15. Output voltage should be 4.0-5.0 volts.

NOTE: Voltage should drop 0.5-1.5 volts with hot engine, at idle.

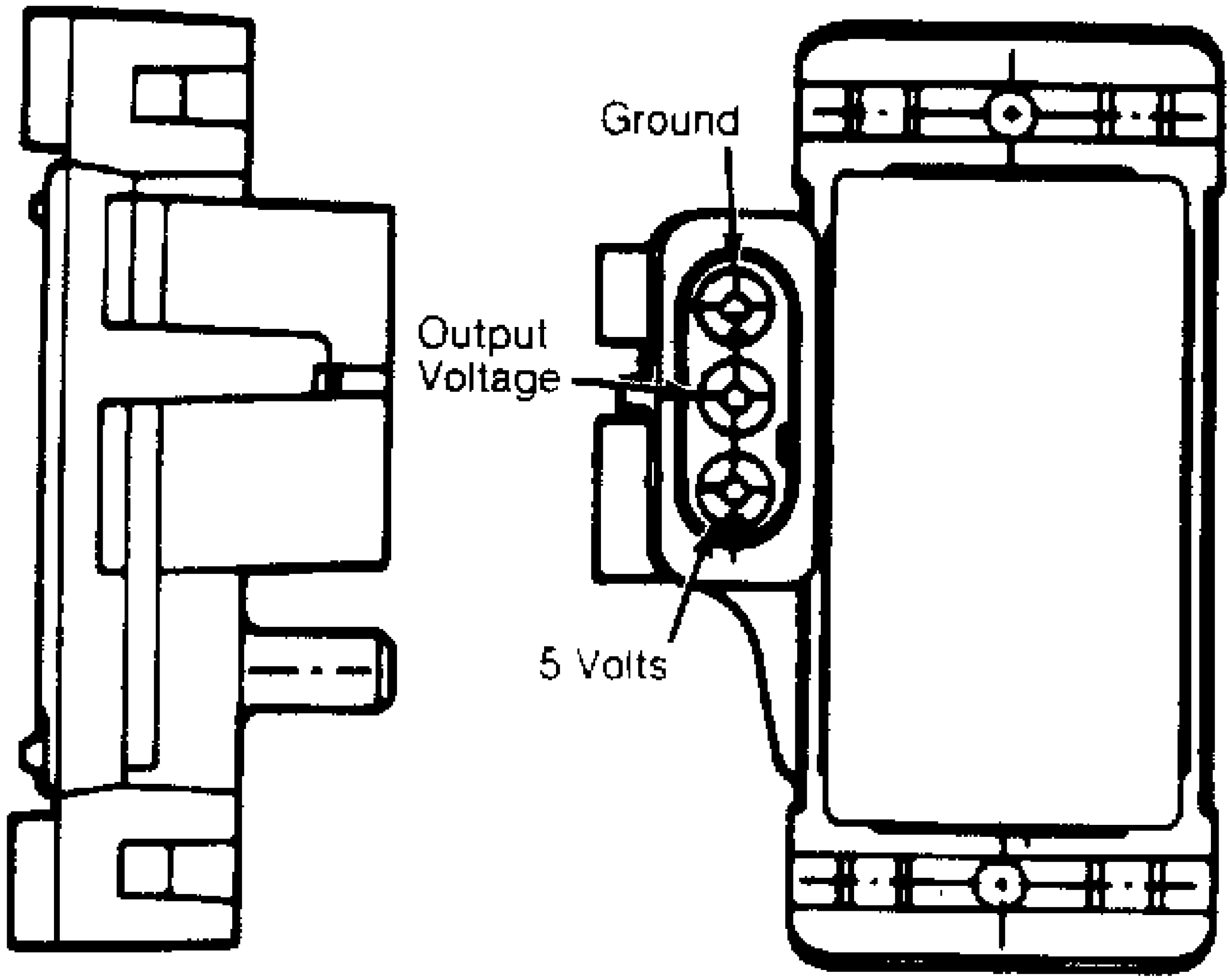


Fig. 6: MAP Sensor Terminal Identification
If markings on MAP sensor vary from illustration, use markings on sensor.

2) Test voltage at pin 33 of ECU connector for 4.0-5.0 volts to verify wiring harness condition. Repair if required.

3) With ignition on, check for MAP sensor supply voltage of 4.5-5.5 volts at sensor connector pin C. Similar voltage should be present at pin 16 of ECU connector. Repair or replace wiring harness if required. Test for sensor ground between pin 17 of ECU connector and pin A of sensor connector.

4) Using an ohmmeter, check for ground from pin 17 of ECU connector to pin 2. If an open circuit is indicated, check for a defective sensor ground on the flywheel housing near the starter motor.

5) If ground is good, the ECU must be replaced. Before replacing ECU, check to see if pin 17 of ECU connector is shorted to 12 volts. If so, correct the condition and test ECU before replacing. Refer to the ELECTRONIC CONTROL UNIT TEST.

ELECTRONIC CONTROL UNIT

1) If all components have been checked and/or repaired, but a system failure or problem still exists, the ECU may be at fault. However, the ECU is a very reliable unit and must always be the final component replaced if a doubt exists concerning the cause of a system failure.

2) The only way to confirm an ECU malfunction is to take the unit to an AMC dealer to have it tested. This is the only sure way to avoid replacing a good ECU.

SYSTEM DIAGNOSIS

PRELIMINARY CHECKS

Be sure fuel is actually reaching the injector. Make sure no air is entering the intake or exhaust system above the catalytic converter. Before assuming an engine control system malfunction, inspect the following systems to ensure components are in good condition and are operating properly.

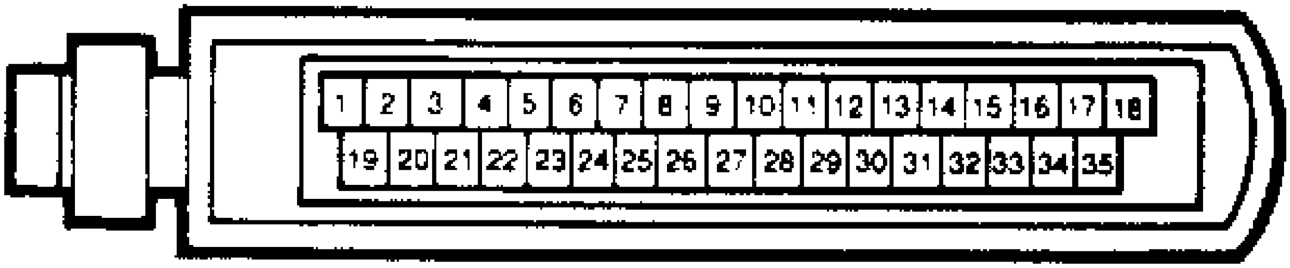
* All support systems and wiring.
* Battery connections and specific gravity.
* Electrical and vacuum connections on components and sensors.
* Emission control devices.
* Ignition system.
* Vacuum hoses.

CAUTION: Never connect or disconnect a component without turning the ignition switch off. Never apply more than 12 volts or AC voltage to system terminals. Disconnect battery cables before charging it. Remove ECU if temperatures are expected to exceed 176°F (80°C), such as in a paint shop bake oven.

DIAGNOSTIC TEST CHARTS

Following are 6 different diagnostic test flow charts, providing the shortest means of testing the system. These include:

* Ignition Switch "OFF" Chart - Tests system power for ECU memory keep-alive voltage.
* Ignition Switch "ON" Power Chart - Tests system power function and fuel pump power function.
* Ignition Switch "ON" Input Chart - Tests closed throttle (idle) switch, wide open throttle (WOT) switch, manifold absolute pressure (MAP) sensor, park/neutral switch, coolant temperature sensor (CTS), manifold air/fuel temperature (MAT) sensor and the respective switch or sensor circuits.
* System Operational Chart - Tests engine start-up and fuel injector circuits, plus function of closed loop air/fuel mixture, coolant temperature sensor, manifold air/fuel temperature sensor, knock sensor and closed loop ignition retard/advance, EGR valve and canister purge solenoid, idle speed actuator, and A/C control.
* Basic Engine Chart - Indicates possible failures within other engine related components.
* Man. Trans. Up-shift Chart - Tests up-shift indicator lamp function on manual transmission vehicles.



1. Ground
2. Ground.
3. Ignition Switch
4. Battery
5. EGR/Canister Purge
6. Fuel Pump Relay
7. System Power Relay
8. WOT Switch
9. Not Used
10. System Ground
11. Speed Sensor
12. Park/Neutral Switch
13. TPS Ground
14. MAT Sensor
15. CTS Sensor
16. MAP Supply Voltage
17. MAP Ground
18 Shift Lamp (Man. Trans.)
19. System Power (B+)
20. Not Used
21. Injector
22. A/C Compressor Clutch
23. ISA Motor Retract
24. ISA Motor Extend
25. Closed Throttle Switch
26. Not Used
27. Ignition Output
28. Speed Sensor
29. Start
30 A/C Control Switch
31 Throttle Paoition Sensor
32. Sensor Ground
33. MAP Output Voltage
34. A/C Temp. Control
35. Oxygen Sensor

Fig. 7: ECU Connector Terminal Identification

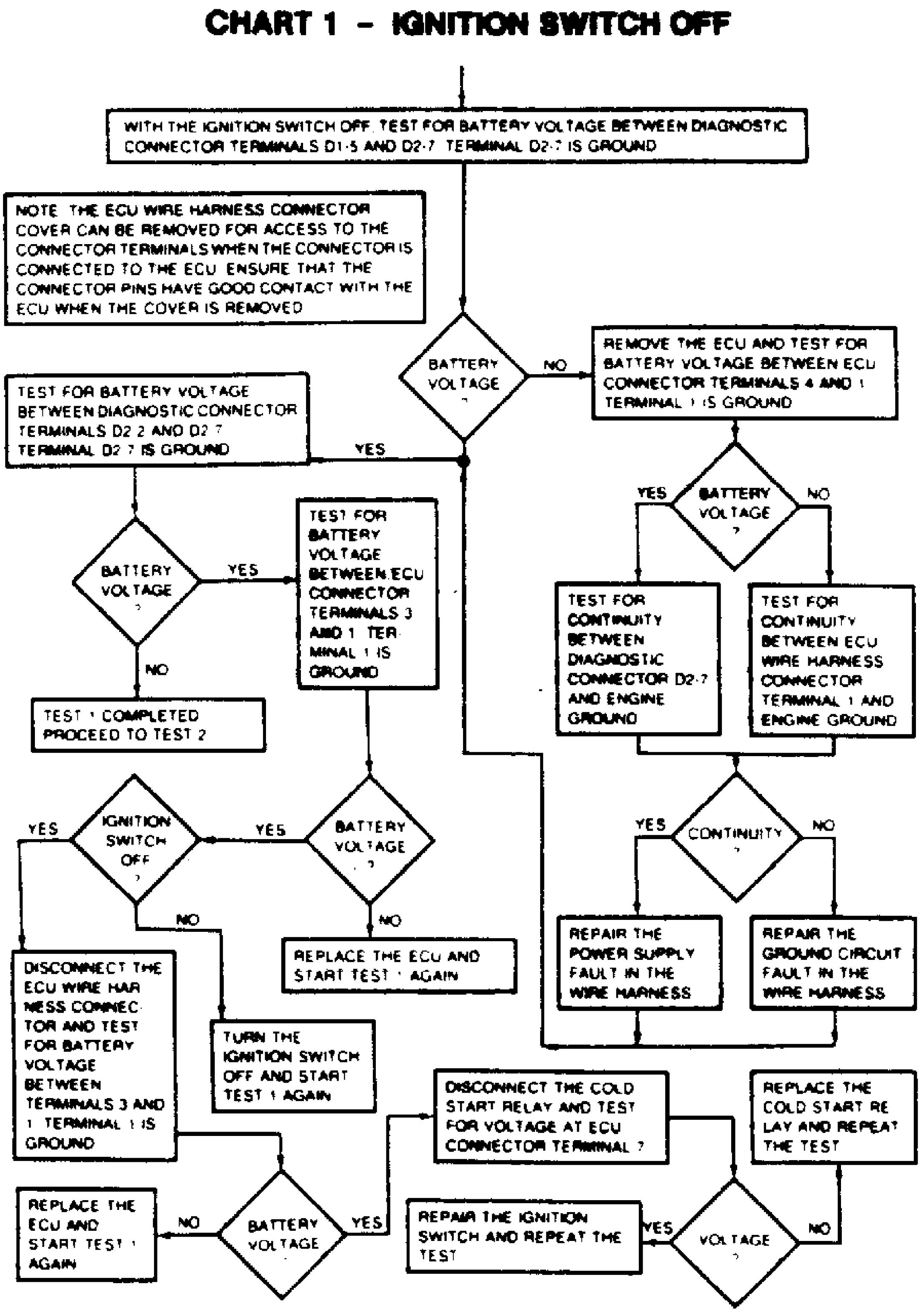


Fig. 8: Chart 1 - Ignition Switch Off

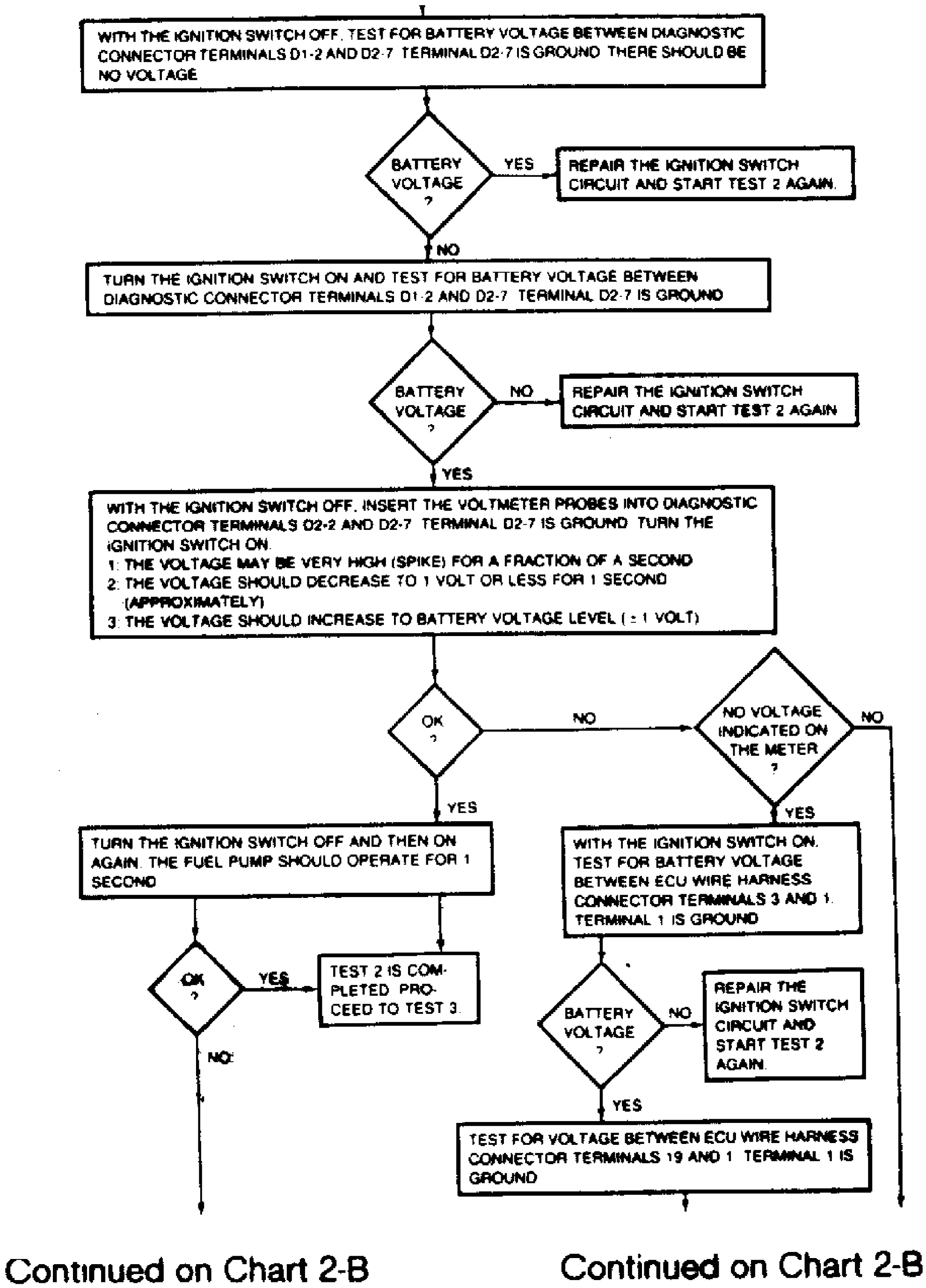


Fig. 9: Chart 2-A - Ignition Switch On

CHART 2-B - IGNITION SWITCH ON (Cont.)

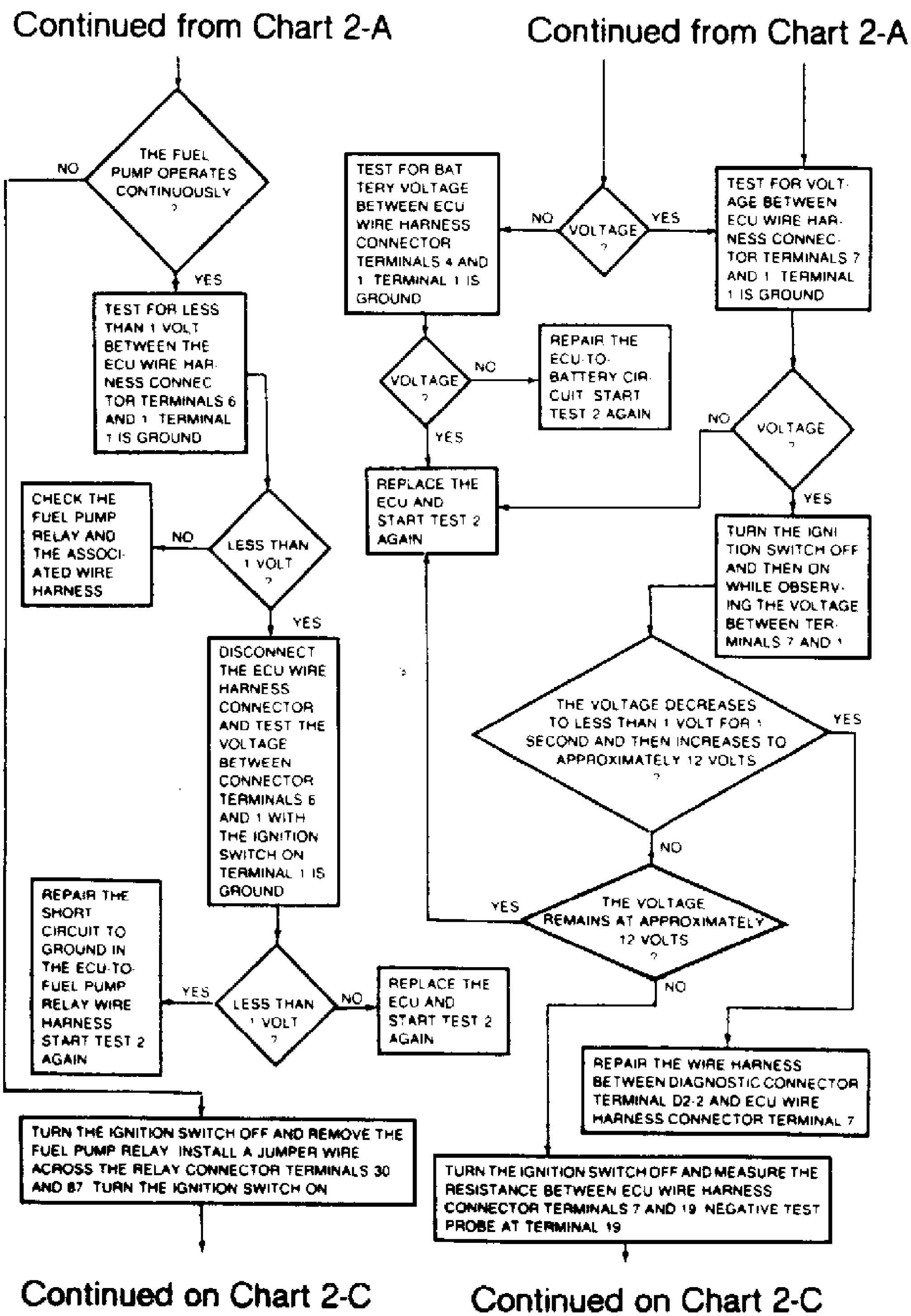


Fig. 10: Chart 2-B - Ignition Switch On (Cont.)

CHART 2-C - IGNITION SWITCH ON (Cont.)

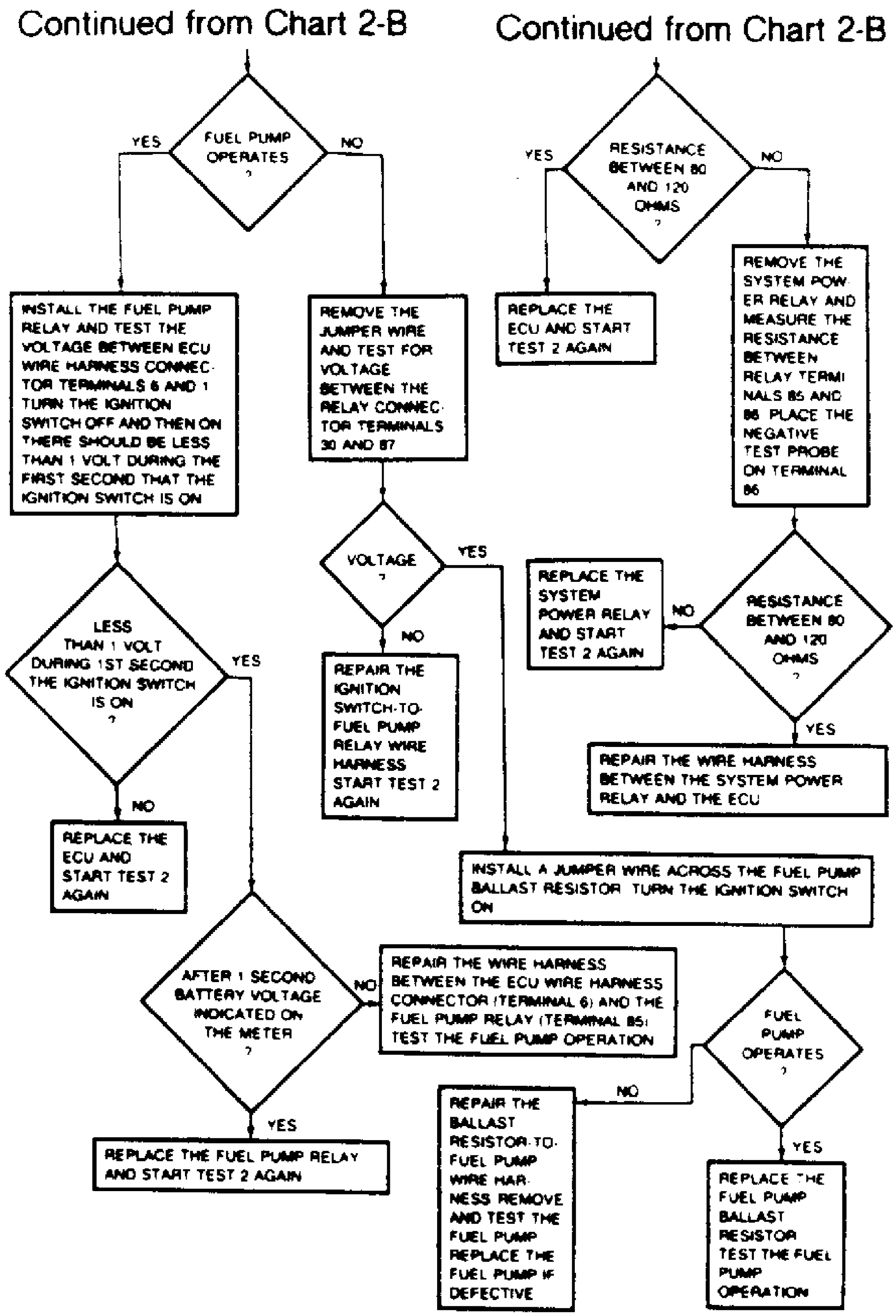
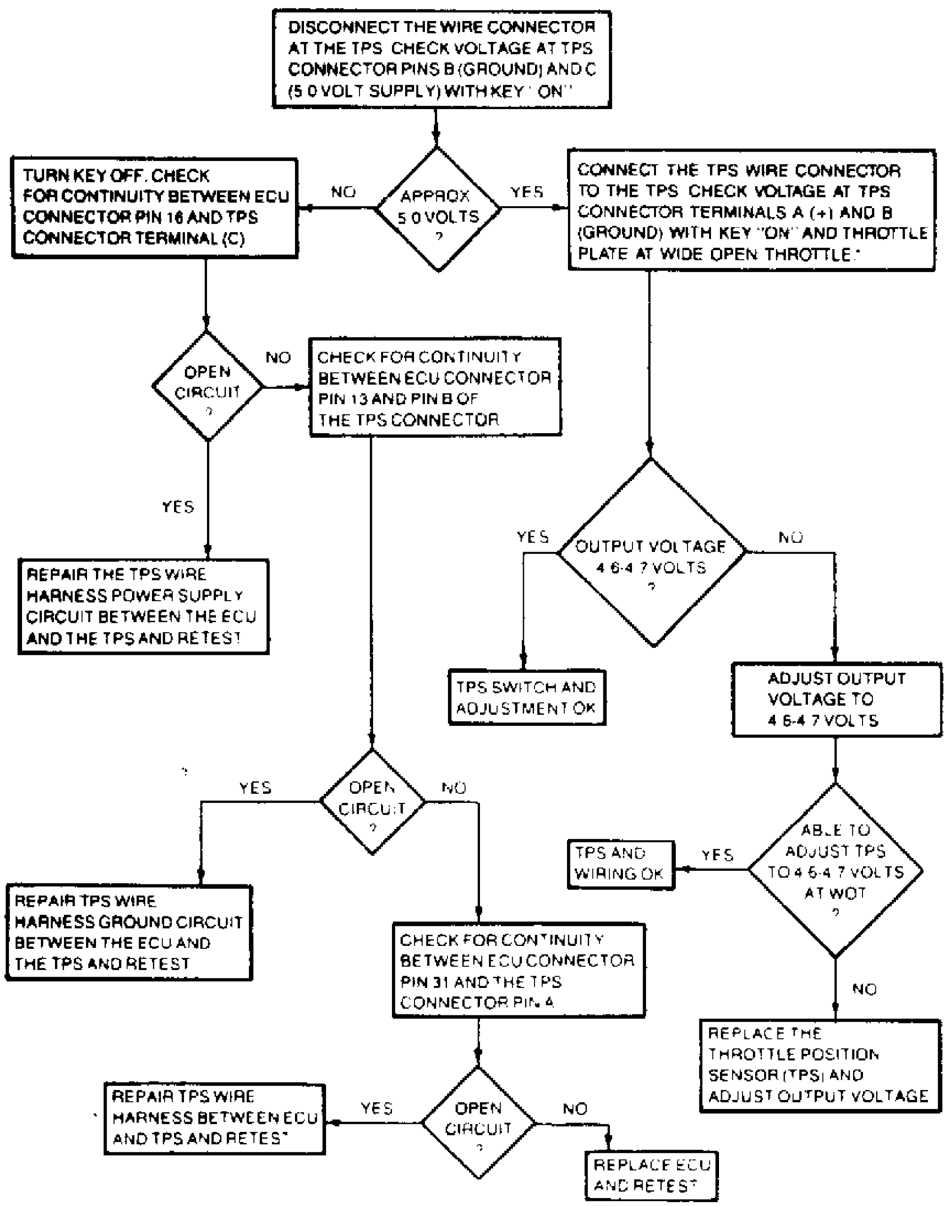


Fig. 11: Chart 2-C - Ignition Switch On (Cont.)

CHART 3 - THROTTLE POSITION SENSOR TEST



* DO NOT UNFASTEN THE SENSOR WIRE HARNESS CONNECTOR INSERT THE VOLTMETER TEST LEADS THROUGH THE BACK OF THE WIRE HARNESS CONNECTOR TO MAKE CONTACT WITH THE SENSOR TERMINALS ON SOME MODELS. IT MAY ALSO BE NECESSARY TO REMOVE THE THROTTLE BODY FROM THE INTAKE MANIFOLD, TO GAIN ACCESS TO THE SENSOR WIRE HARNESS CONNECTOR

Fig. 12: Chart 3 - Throttle Position Sensor Test

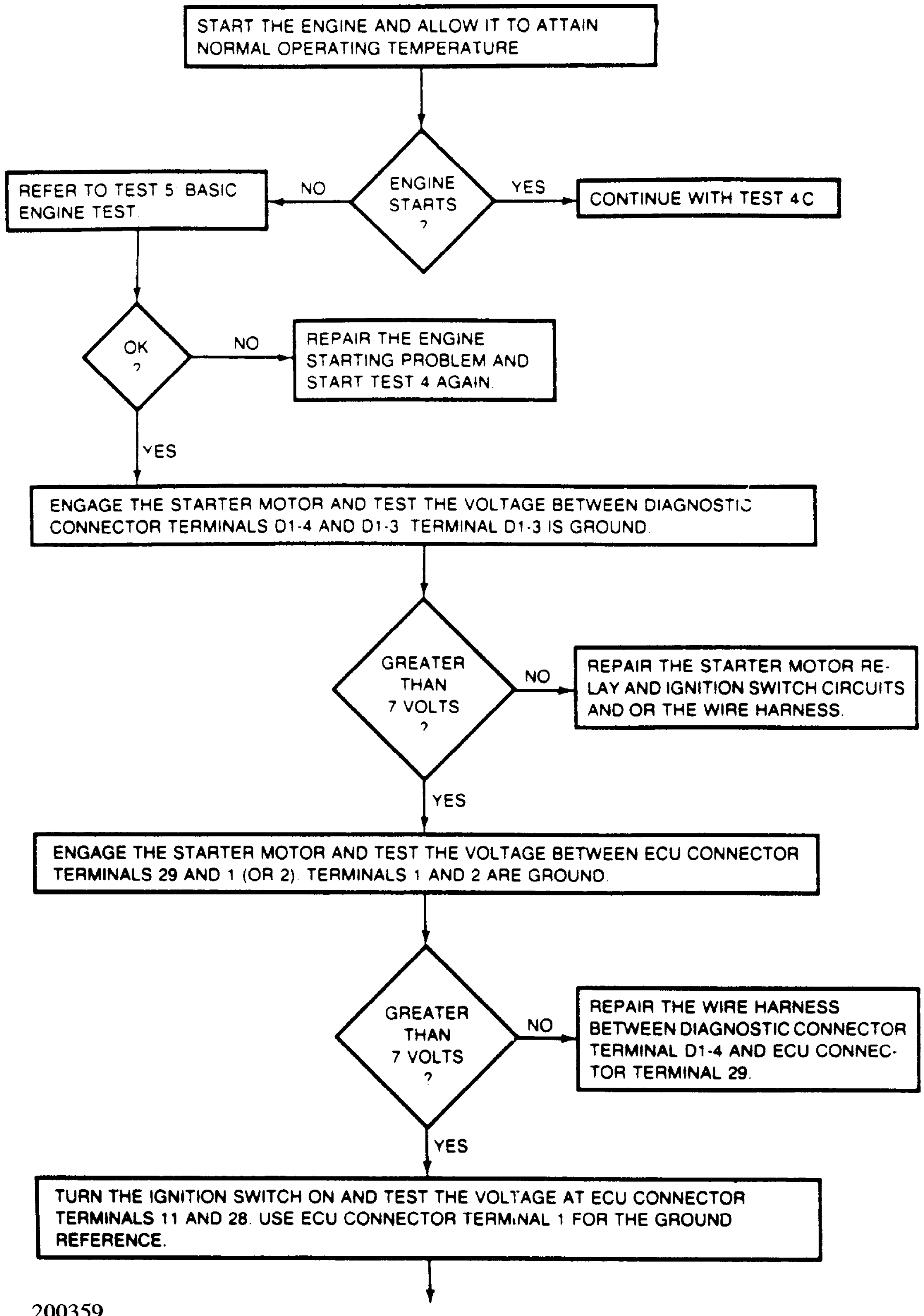


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Fig. 13: Chart 4-A - System Operational Test

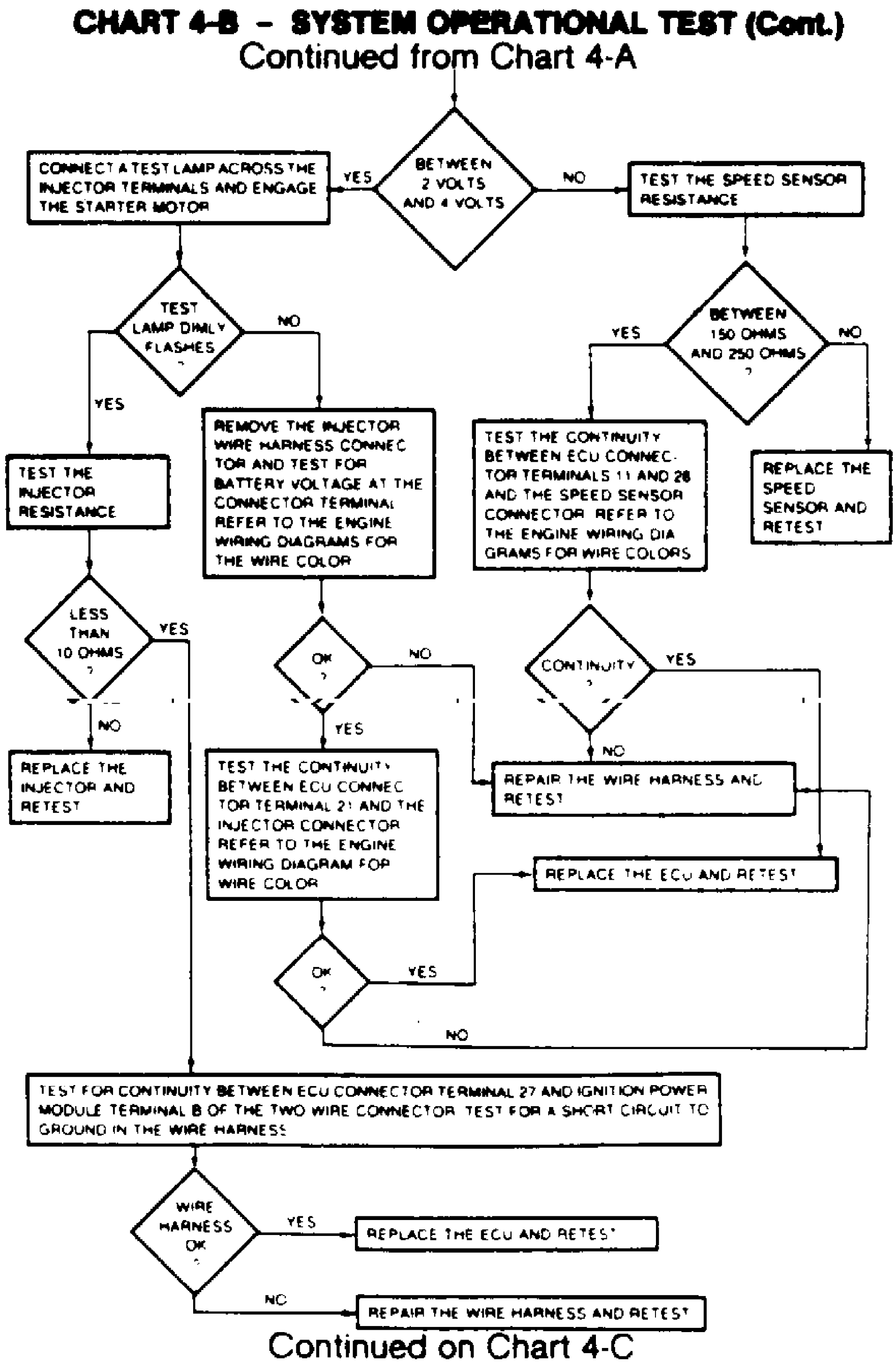
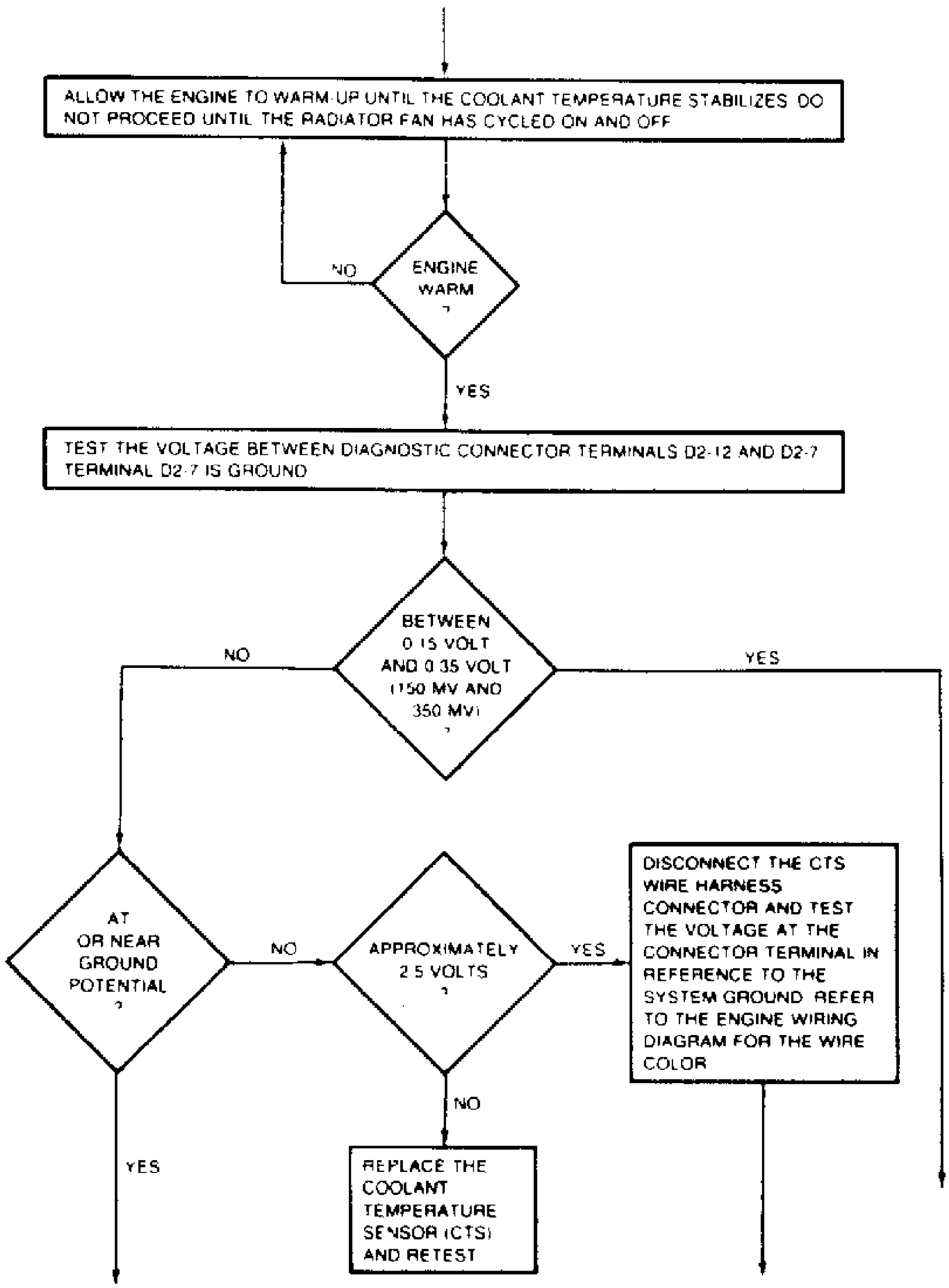


Fig. 14: Chart 4-B - System Operational Test (Cont.)

CHART 4-C - SYSTEM OPERATIONAL TEST (Cont.)

Continued from Chart 4-B



Continued on Chart 4-D

Fig. 15: Chart 4-C - System Operational Test (Cont.)

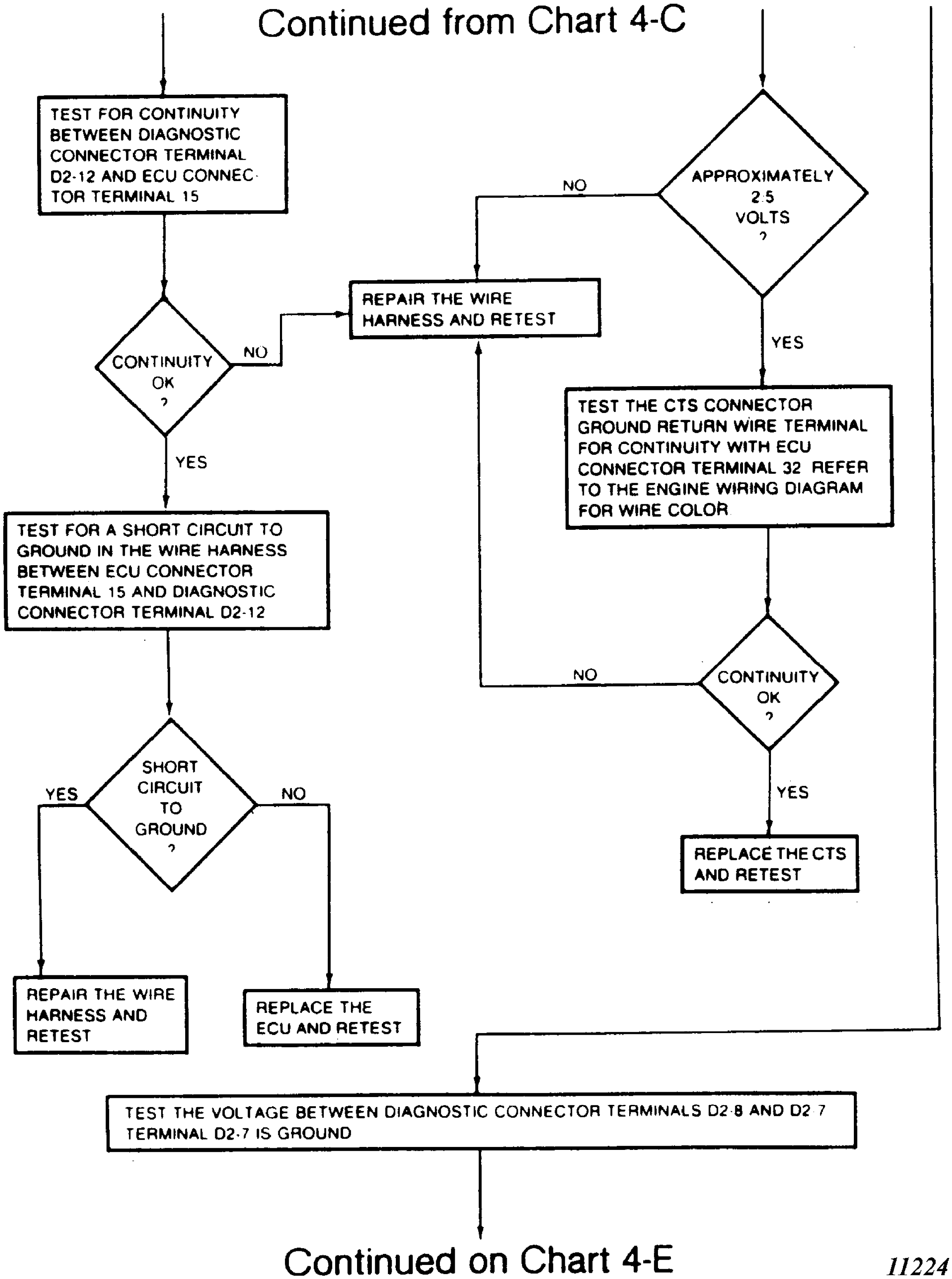
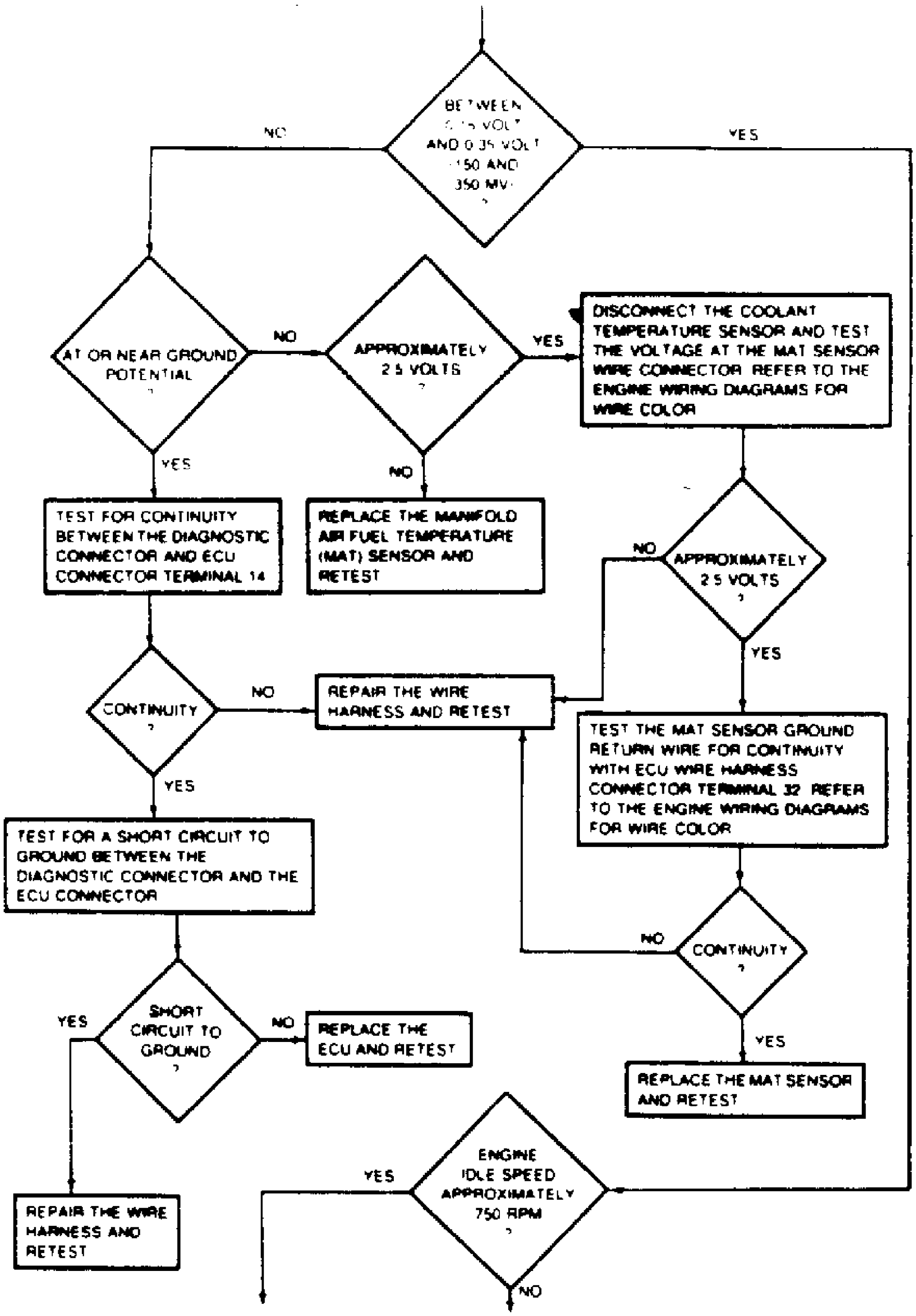


Fig. 16: Chart 4-D - System Operational Test (Cont.)

CHART 4-E - SYSTEM OPERATIONAL TEST (Cont.)

Continued from Chart 4-D



Continued on Chart 4-F Continued on Chart 4-F

Fig. 17: Chart 4-E - System Operational Test (Cont.)

CHART 4-F - SYSTEM OPERATIONAL TEST (Cont.)

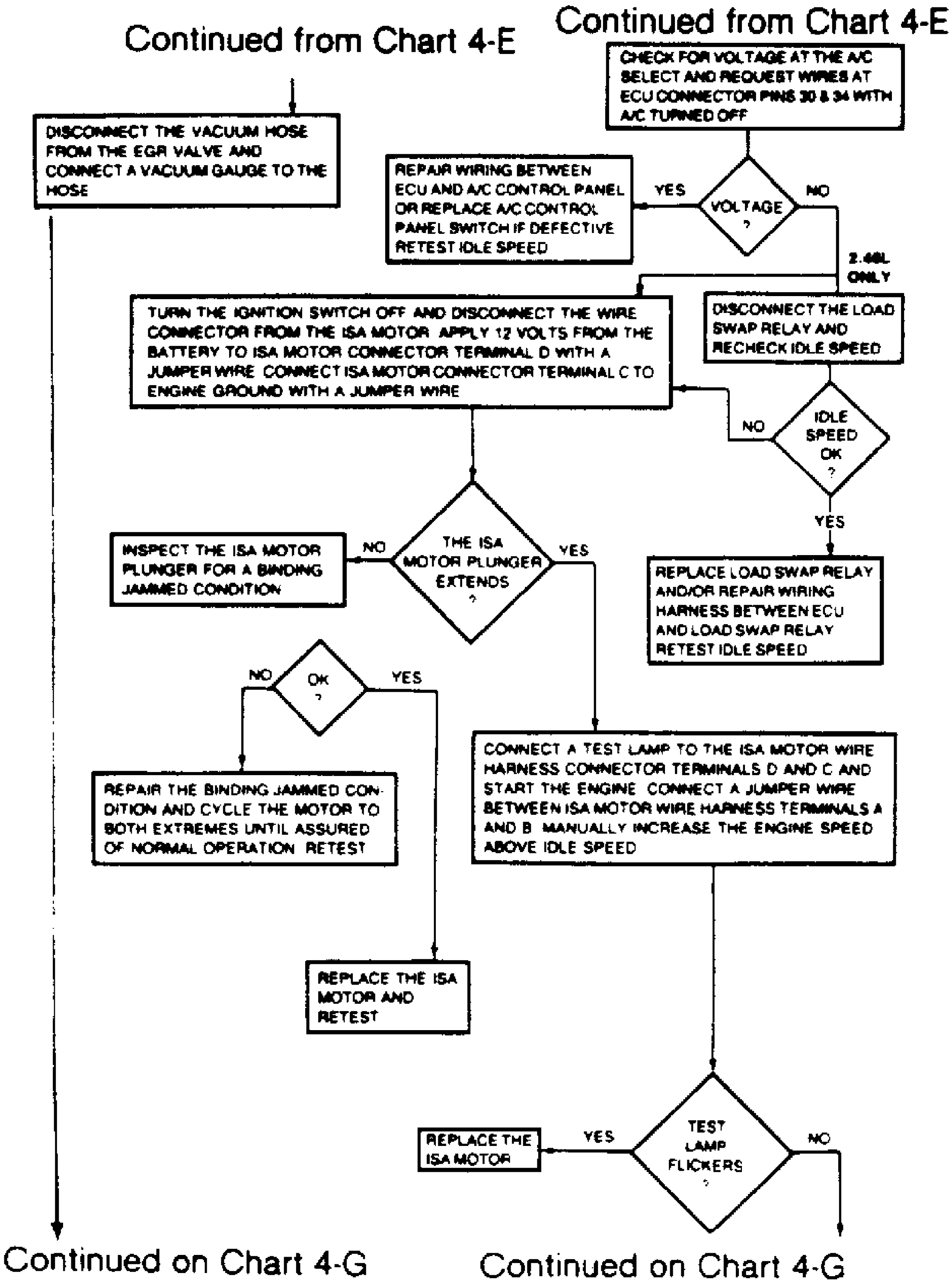
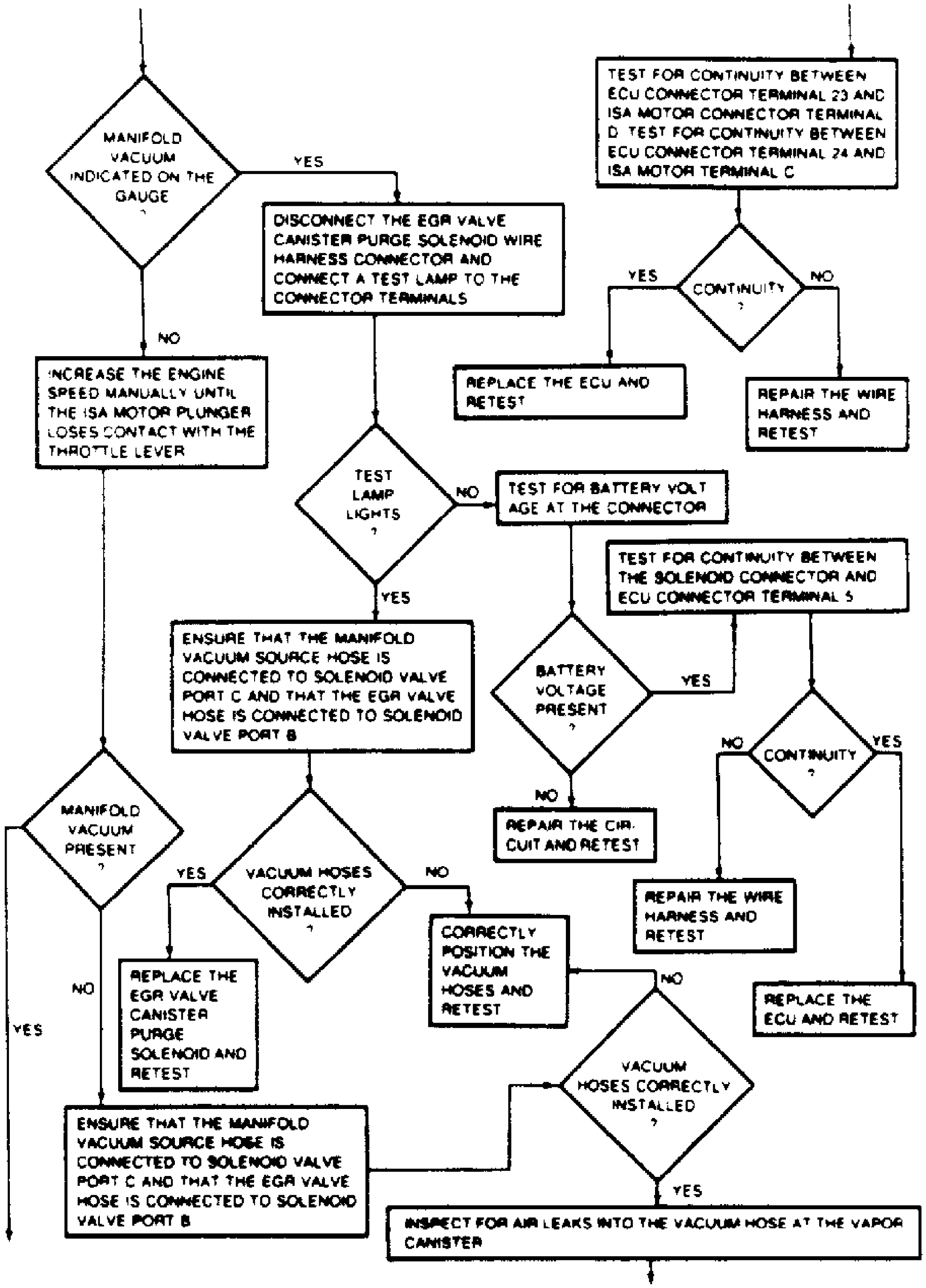


Fig. 18: Chart 4-F - System Operational Test (Cont.)

CHART 4-G - SYSTEM OPERATIONAL TEST (Cont.)

Continued from Chart 4-F

Continued from Chart 4-F



Continued on Chart 4-H

Continued on Chart 4-H

Fig. 19: Chart 4-G - System Operational Test (Cont.)

CHART 4-H - SYSTEM OPERATIONAL TEST (Cont.)

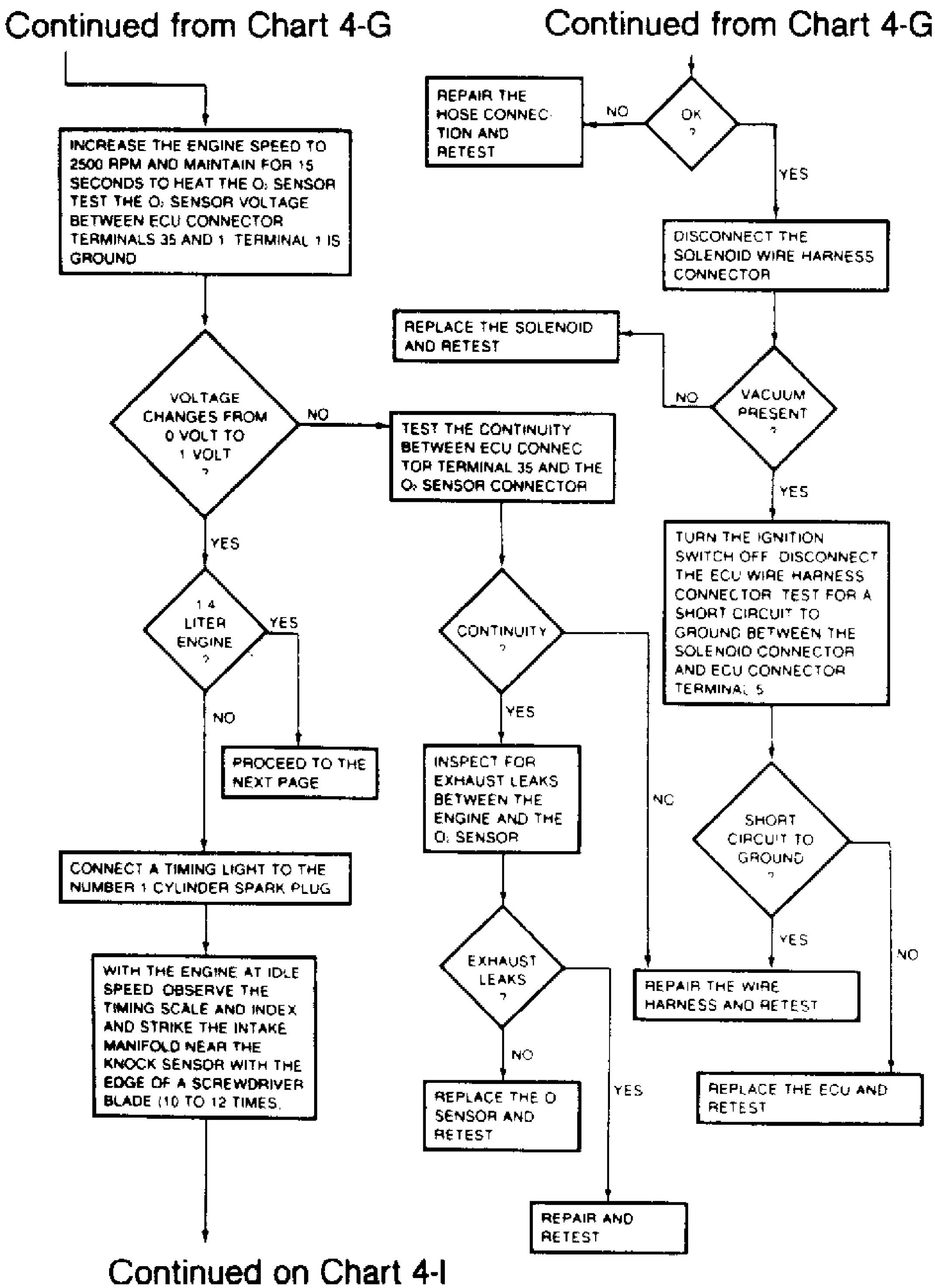
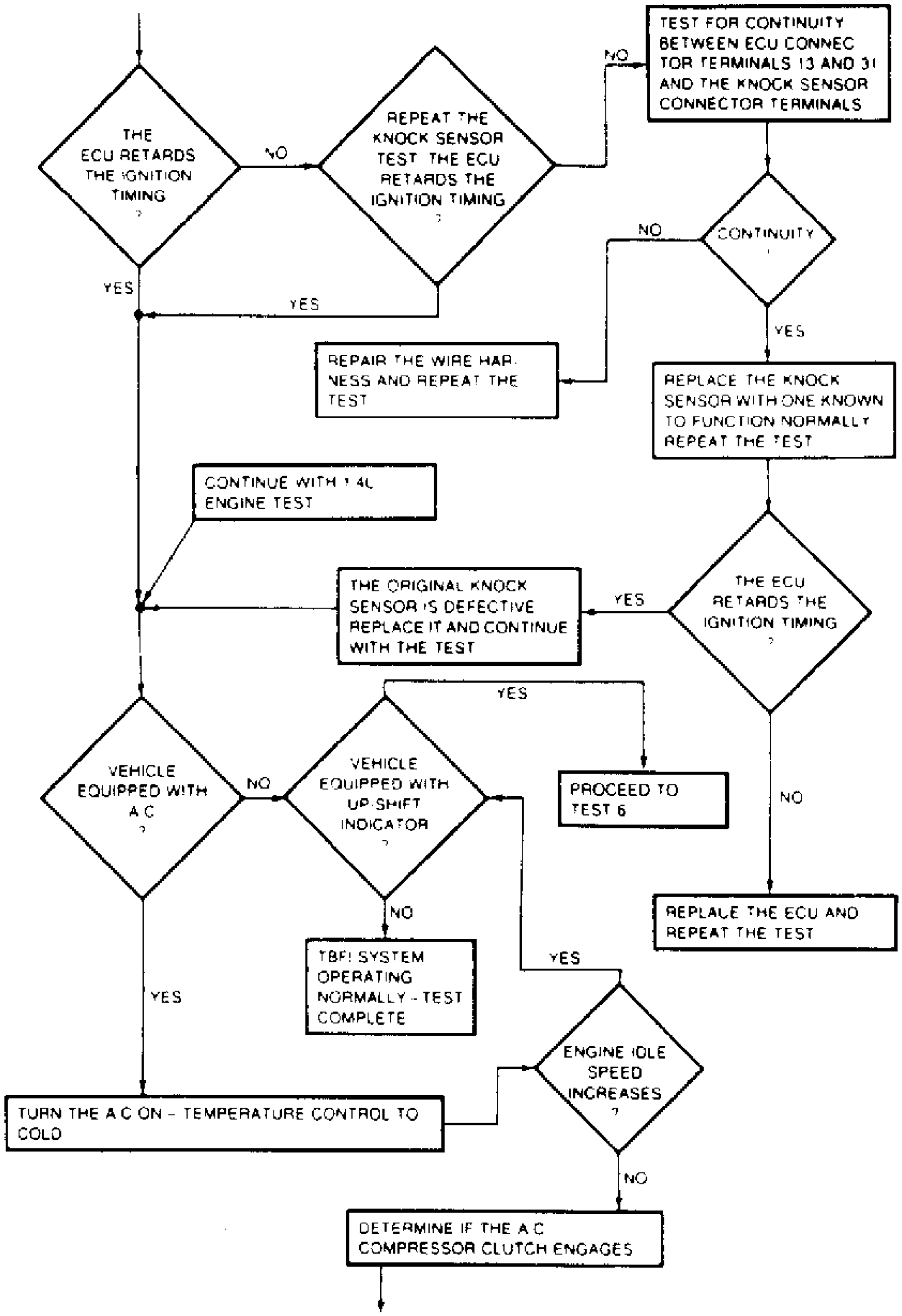


Fig. 20: Chart 4-H - System Operational Test (Cont.)

CHART 4-I - SYSTEM OPERATIONAL TEST (Cont.)

Continued from Chart 4-H

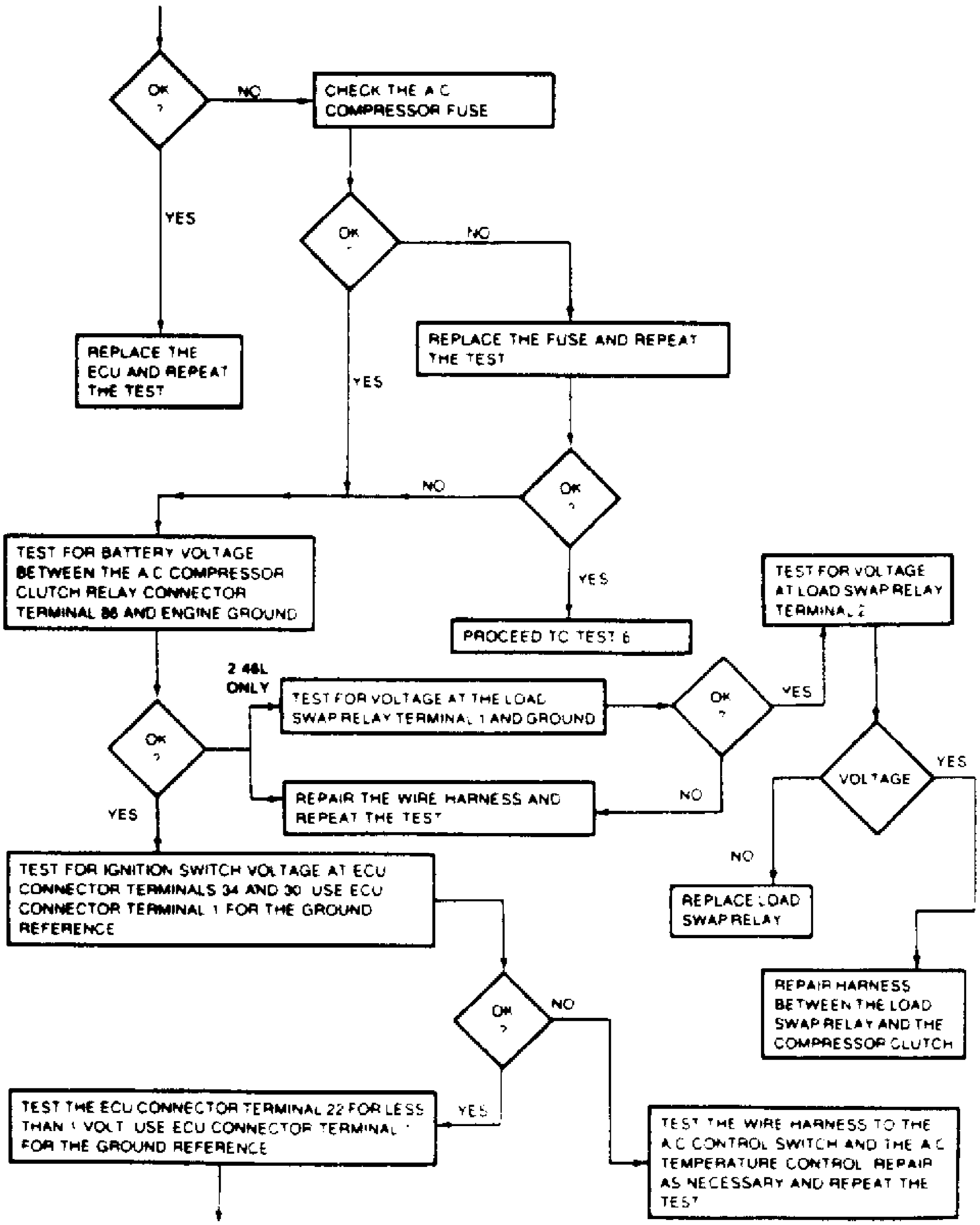


Continued on Chart 4-J

Fig. 21: Chart 4-I - System Operational Test (Cont.)

CHART 4-J - SYSTEM OPERATIONAL TEST (Cont.)

Continued from Chart 4-I



Continued on Chart 4-K

Fig. 22: Chart 4-J - System Operational Test (Cont.)

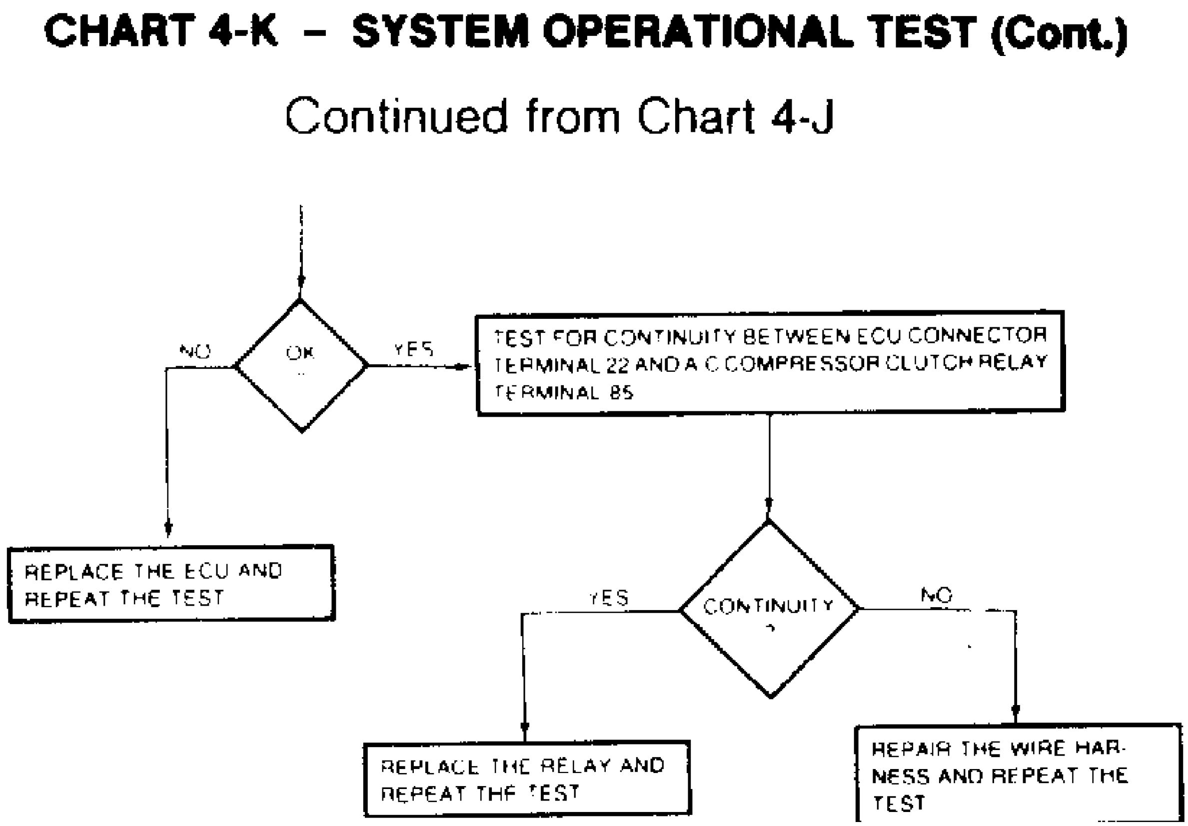


Fig. 23: Chart 4-K - System Operational Test (Cont.)

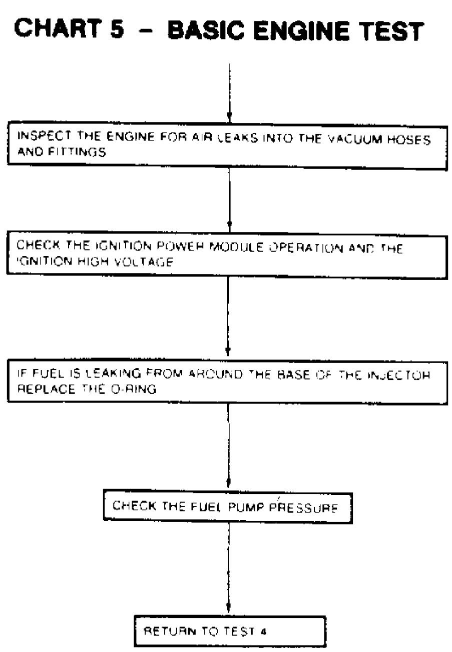


Fig. 24: Chart 5 - Basic Engine Test

CHART 6-A - MAN. TRANS. UP-SHIFT TEST

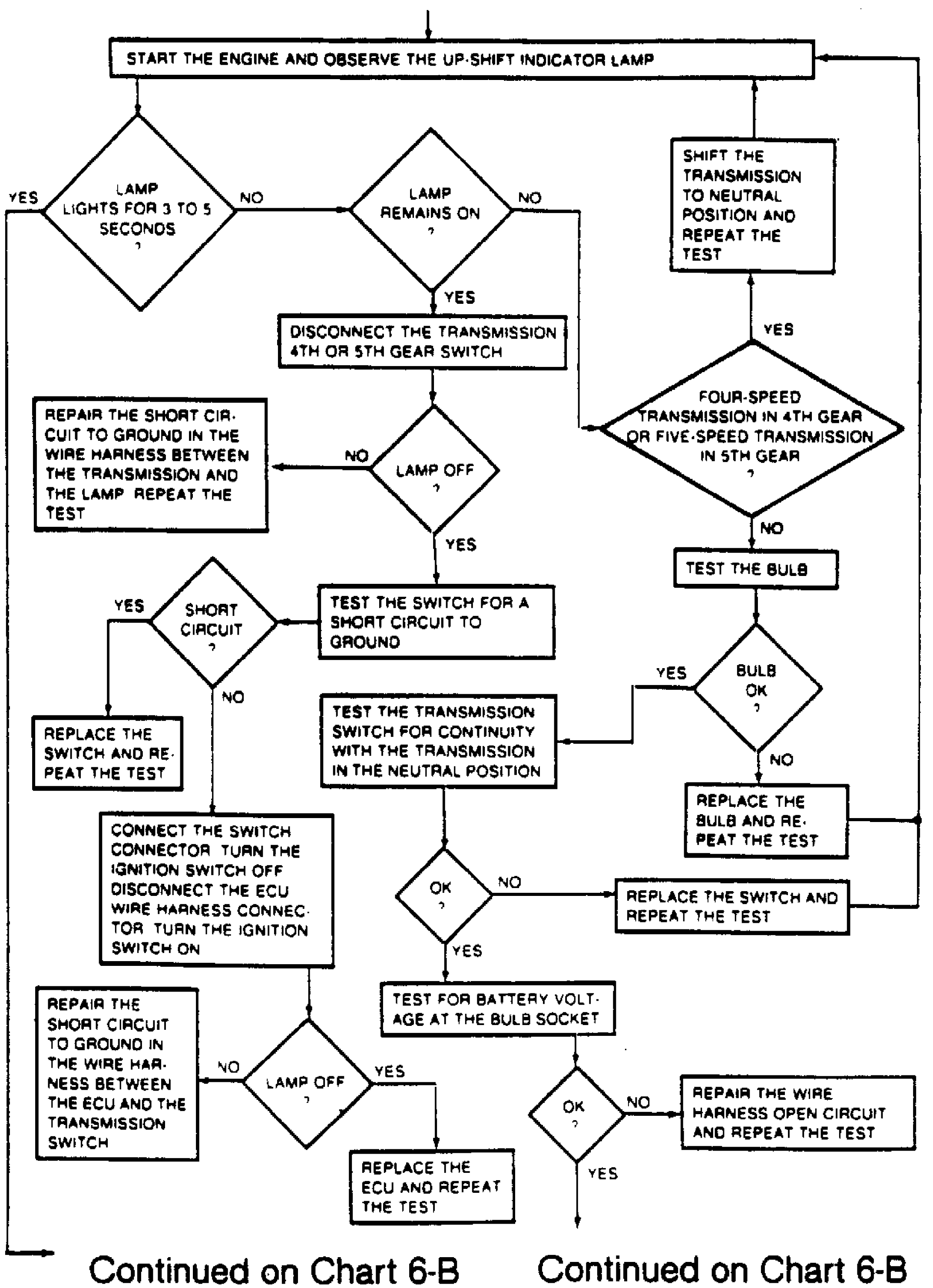


Fig. 25: Chart 6-A - Man. Trans. Up-Shift Test

CHART 6-B - MAN. TRANS. UP-SHIFT TEST (Cont.)

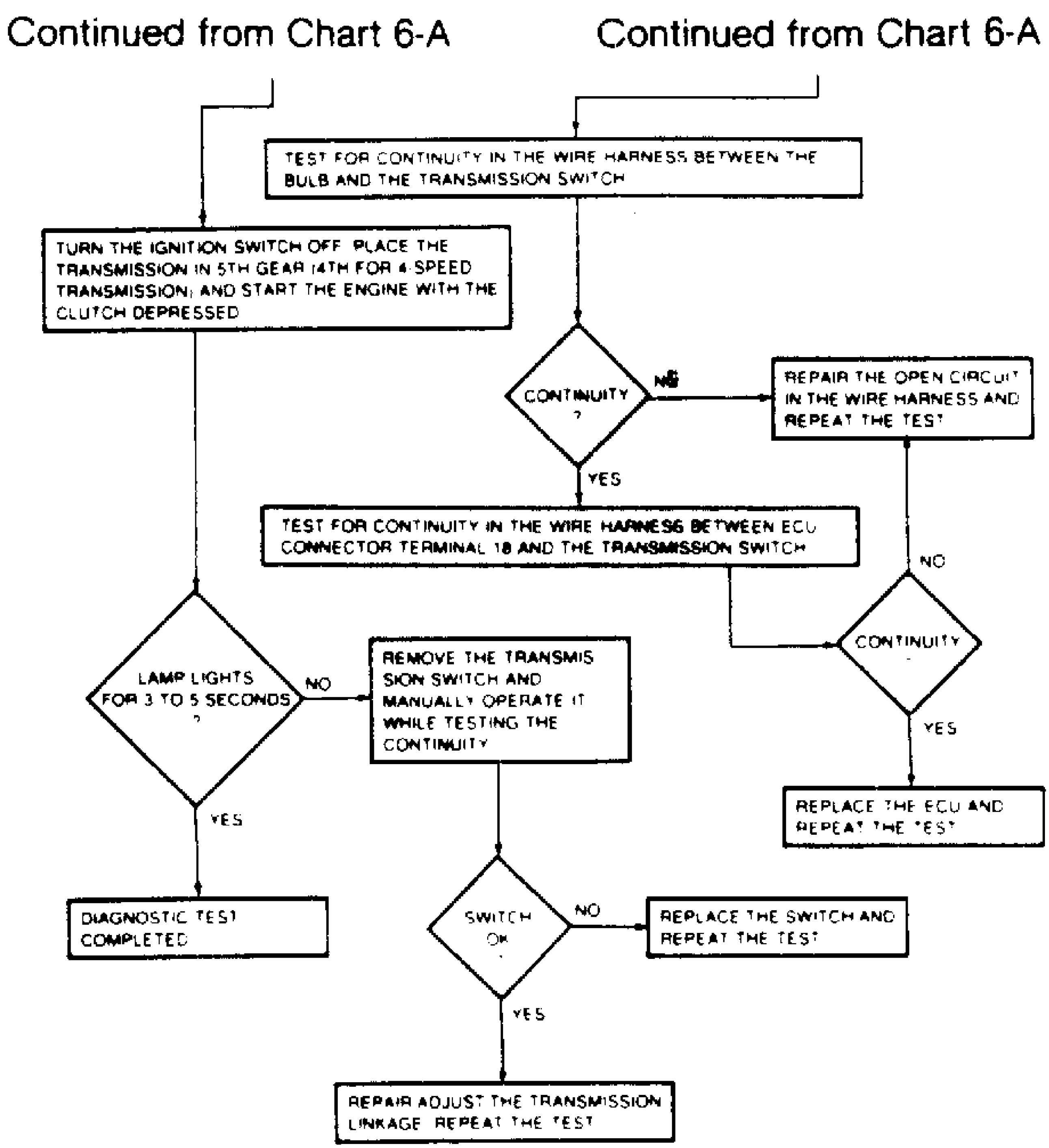


Fig. 26: Chart 6-B - Man. Trans. Up-Shift Test (Cont.)

REMOVAL & INSTALLATION

THROTTLE BODY ASSEMBLY

Removal

1) Remove throttle return spring, throttle cable and cruise control cable, if equipped. Disconnect wiring harness connector from injector, WOT switch, and ISA motor. Remove fuel supply and return pipes from throttle body.

2) Identify and tag vacuum hoses for installation later. Disconnect vacuum hoses from throttle body assembly. Remove throttle body-to-manifold retaining nuts from studs.

3) Remove throttle body assembly from intake manifold. If being replaced, transfer ISA motor and WOT switch and bracket assembly to new throttle body.

Installation

To install, reverse removal procedure using a new gasket between components. Adjust ISA motor and WOT switch.

FUEL INJECTOR

Removal

Remove air cleaner assembly, injector wire connector, and injector retainer clip screws. Using a pair of small pliers, gently grasp center collar of injector (between electrical terminals), and carefully remove injector with a lifting and twisting motion. Note back-up ring fits over upper "O" ring.

Installation

1) Lubricate new lower "O" ring with light oil and install in housing bore. Lubricate new upper "O" ring with light oil and install in housing bore. Install back-up ring over upper "O" ring.

2) Position new injector in fuel body, and center nozzle in lower housing bore. Seat injector with a pushing and twisting motion. Align wire connector terminals properly. Install retainer clip and screws. Connect injector wire connector.

FUEL PRESSURE REGULATOR

Removal

Remove 3 retaining screws, securing pressure regulator to fuel body. After noting location of components for reassembly reference, remove regulator assembly.

Installation

Position pressure regulator assembly with a new gasket. Install 3 retaining screws, securing regulator to throttle body. Adjust regulator. Operate engine and inspect for leaks.

IDLE SPEED ACTUATOR, MOTOR & WIDE OPEN THROTTLE SWITCH

NOTE: Closed throttle (idle) switch is integral with ISA and motor assembly.

Removal

1) Remove air cleaner assembly. Disconnect throttle return spring, throttle cable and cruise control cable, if equipped. Disconnect wiring harness connector from ISA motor and WOT switch.

2) Remove ISA motor and WOT switch bracket from throttle body. Remove motor-to-bracket retaining nuts. See Fig. 23. Do not remove nuts from motor studs.

CAUTION: Do not attempt to remove ISA motor attaching nuts without

using a backup wrench on stud nuts. ISA motor internal components may be dislodged if studs disengage and motor cap comes off.

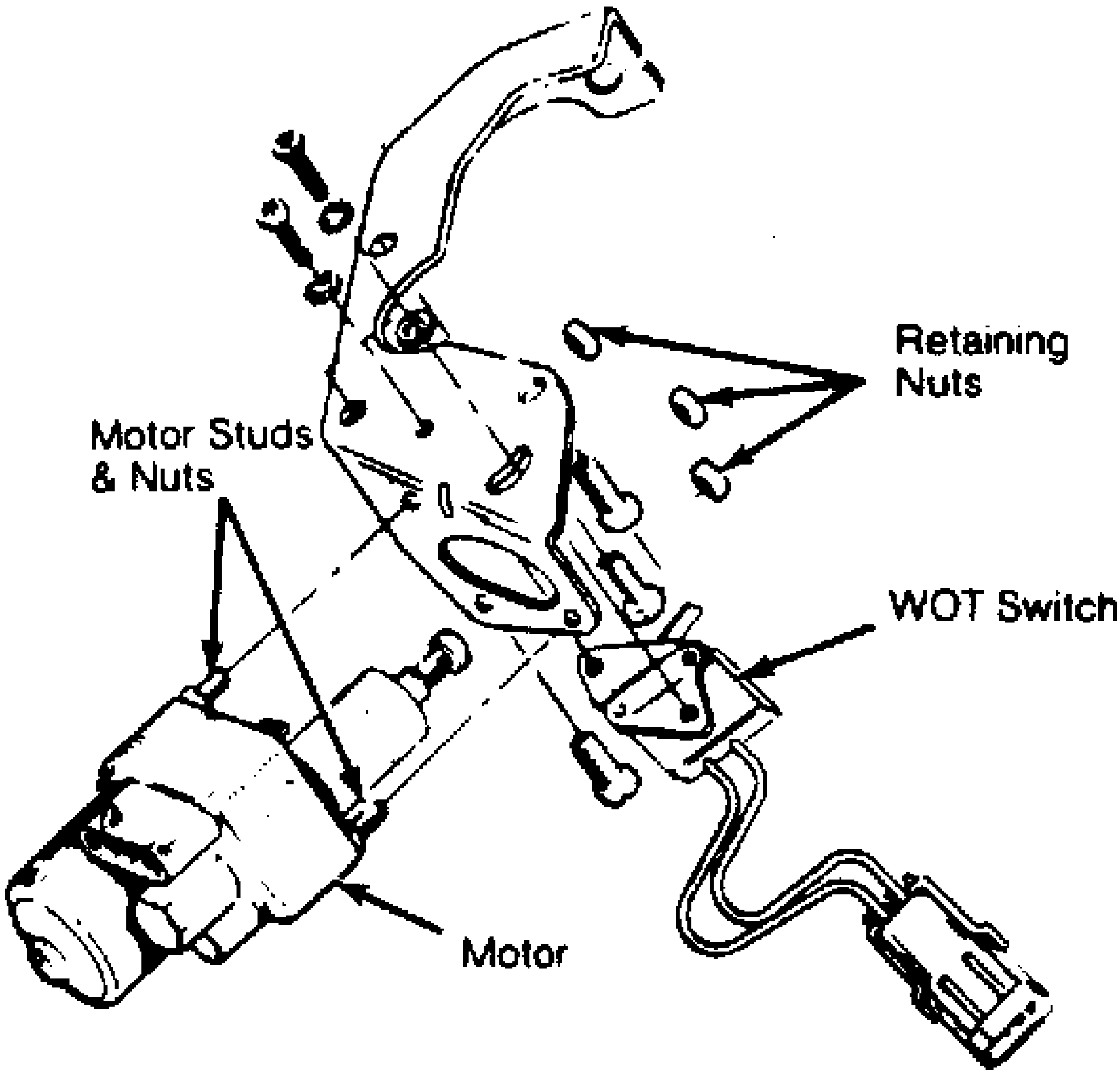


Fig. 27: ISA Motor and WOT Switch Removal
Bracket assembly is mounted on throttle body unit.

3) To remove ISA motor from bracket, place backup 8 mm open end wrench on ISA motor stud nuts to prevent studs from turning. Grind wrench until thin enough to fit between motor and bracket. Remove ISA motor attaching nuts. Remove 2 WOT switch-to-bracket screws. Remove WOT switch.

Installation

1) Install new WOT switch on bracket and tighten 2 screws. Install ISA and motor on bracket. Install motor-to-bracket retaining

nuts. Install motor and WOT switch bracket assembly on throttle body.

2) Connect wiring harness connector to ISA motor and WOT switch. Connect the throttle return spring, throttle cable and cruise control cable. Adjust ISA motor and WOT switch. Install air cleaner assembly.

NOTE: After replacing or reinstalling the original ISA motor, be sure motor plunger is fully extended before starting the engine. If plunger is not fully extended, the closed throttle switch may open prematurely, causing idle speed to drop to approximately 400 RPM.

3) Start engine with throttle at 1/4 open position. This prevents ISA plunger from retracting. Stop engine. When ignition is turned off, the motor plunger will fully extend. After installation is complete, adjust ISA as required.

ELECTRONIC CONTROL UNIT

Removal & Installation

Locate ECU in passenger compartment, below glove box. Remove retaining screws and mounting bracket. Remove the ECU, and disconnect wiring harness connector from ECU. Reverse removal procedure to install.

OXYGEN SENSOR

Removal

Disconnect the wire connector from sensor, and unscrew sensor from exhaust pipe adapter. Clean adapter threads.

Installation

1) Apply anti-seize compound to sensor threads. Do not allow compound to adhere to any other part of sensor. Hand start the sensor into place and tighten. Check that wire terminal ends are properly seated in connector. Connect wire.

2) Do not push the rubber boot over sensor body lower than 1/2" (13 mm) above base of sensor. If the sensor wire should break, sensor must be replaced. These wires cannot be spliced or otherwise repaired.

MANIFOLD AIR TEMPERATURE & MANIFOLD ABSOLUTE PRESSURE SENSORS

Removal & Installation

Disconnect wiring harness connector from sensor. Disconnect vacuum hose from MAP sensor. Remove sensor. Clean MAT sensor manifold threads, and wrap with Teflon tape. To install, reverse removal procedure.

COOLANT TEMPERATURE SENSOR (CTS)

Removal & Installation

Allow engine to cool and release pressure from cooling system. Remove wiring harness from sensor. Remove sensor at rear of intake manifold, and plug hole to prevent excessive coolant loss. To install, reverse removal procedure and replace lost coolant.

EGR VALVE & CANISTER PURGE SOLENOID

Removal & Installation

Disconnect wiring harness and vacuum hose from solenoid. Remove solenoid and bracket as an assembly. Replace solenoid as an

assembly. To install, reverse removal procedure.

ADJUSTMENTS

NOTE: The following adjustment procedures should not be necessary during normal vehicle operation or maintenance. Adjustment of the listed components should only be required when a faulty component is replaced with a new one.

IDLE SPEED ACTUATOR (ISA) MOTOR

1) With air cleaner removed, air conditioner off (if equipped) and engine at normal operating temperature, connect a tachometer to terminals 1 (+) and 3 (-) of the small diagnostic connector D1. See Fig. 16. Turn ignition off and observe ISA motor plunger. The plunger should move to fully extended position.

2) With ISA plunger fully extended, disconnect wire connector and start engine. Engine speed should be 3300-3700 RPM. If not, turn hex head screw on end of plunger until correct speed is obtained.

3) Hold closed throttle switch plunger all the way in while opening throttle. Release the throttle. Throttle lever should not make contact with the plunger. If contact is made, inspect throttle linkage and/or cable for binding or damage. Repair as needed.

4) Reconnect ISA motor wire connector and turn ignition off for 10 seconds. Motor should move to fully extended position. Start engine. Engine speed should be 3300-3700 RPM for a short time and then fall to normal idle. Turn off engine and remove tachometer.

5) When final adjustments have been made, apply thread sealer to adjustment screw threads to prevent movement. Install air cleaner.

WIDE OPEN THROTTLE SWITCH

1) Remove the throttle body assembly from the engine, and loosen 2 WOT switch retaining screws. Hold throttle in wide open position, and attach a Throttle Angle Gauge (J-26701) to flat surface of the throttle lever.

2) Rotate scale to align the 15° mark with the pointer. Level the gauge. Rotate scale to align zero with the pointer, and close the throttle enough to center bubble. This positions the throttle at 15° before wide open throttle.

3) Adjust the WOT switch lever on the throttle cam so that the plunger is just closed at 15° position. Tighten the retaining screws, and remove the gauge.

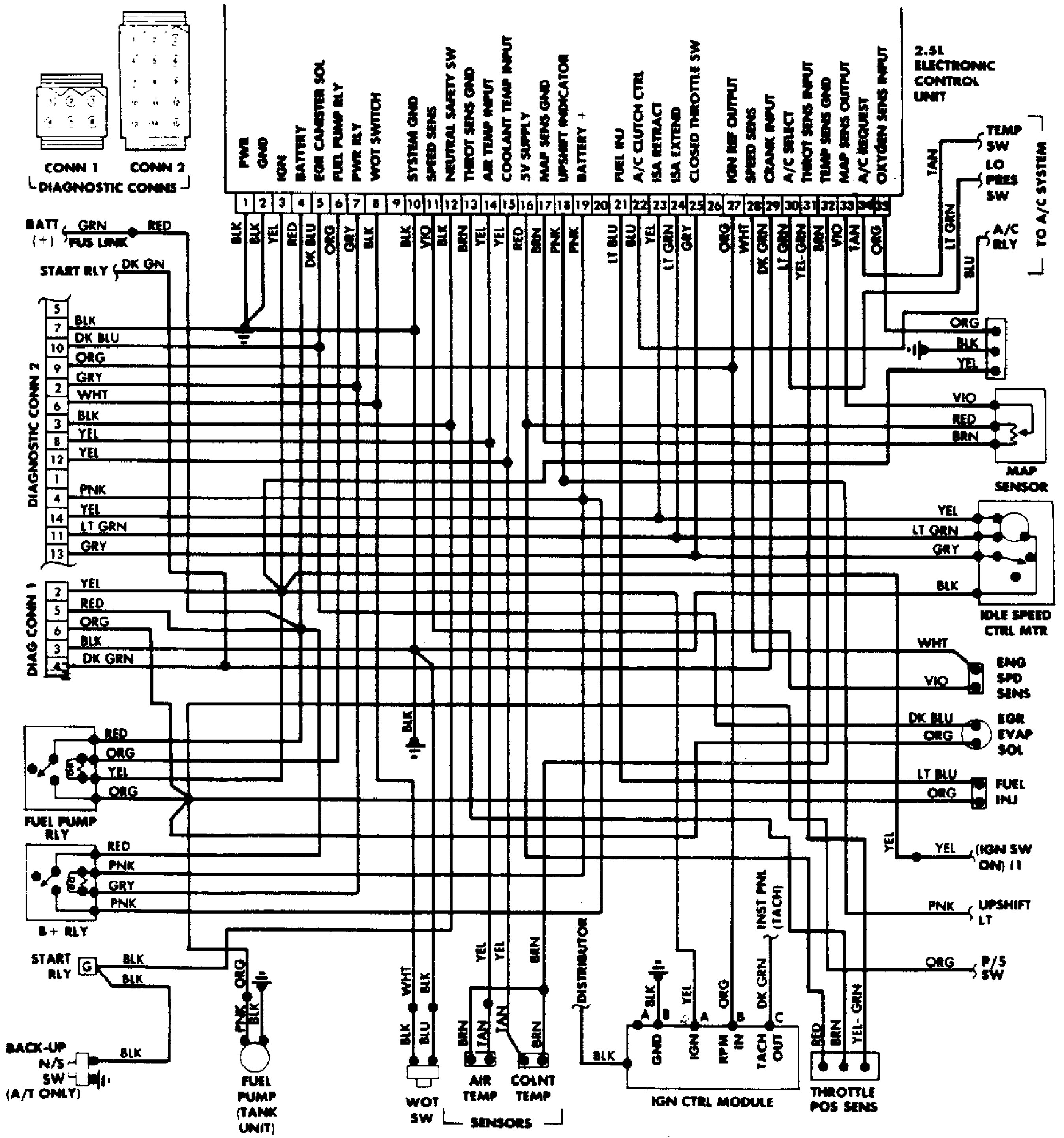


Fig. 28: Jeep 2.5L TBI System Wiring Diagram

FUEL PRESSURE REGULATOR

1) Remove air cleaner assembly. Connect a tachometer to terminals 1 and 3 of small diagnostic connector D1. Remove screw plug and install special Fuel Pressure Test Fitting (8983 501 572).

2) Connect accurate fuel pressure gauge to fuel pressure test fitting. Start engine and accelerate to 2000 RPM. Turn torx head adjustment screw on bottom of fuel regulator to obtain 17.3 psi (1.2 kg/cm(C)) of fuel pressure.

NOTE: Turning screw inward increases pressure; turning screw outward decreases it.

3) After specification is reached, install a lead seal ball to cover regulator adjustment screw. Turn ignition switch off, and disconnect tachometer. Disconnect fuel pressure gauge, remove test fitting, and install original plug screw. Install air cleaner assembly.

1988 ENGINES
Chrysler Motors 4.0L & 4.2L 6-Cylinder

Jeep; Cherokee, Comanche, Wagoneer, Wrangler

ENGINE CODING

ENGINE IDENTIFICATION

NOTE: For engine repair procedures not covered in this article, see ENGINE OVERHAUL PROCEDURES - GENERAL INFORMATION article in the GENERAL INFORMATION section.

The Vehicle Identification Number (VIN) is located on upper left side of dash and is visible through windshield. The fourth character identifies the engine size. The tenth character identifies the model year.

ENGINE IDENTIFICATION CODES TABLE

Application	VIN Code
4.0L 6-Cylinder MPFI	M
4.2L 6-Cylinder 2-Bbl.	C

SPECIAL ENGINE MARKS

Some engines are produced at factory with oversize or undersize components. These engines are identified by a letter code stamped on a boss between ignition coil and distributor. Letters are decoded as follows:

* "B" indicates all cylinder bores are .010" (.25 mm) oversize.
* "C" indicates all camshaft bearing bores are .010" (.25 mm) oversize.
* "M" indicates all main bearing journals are .010" (.25 mm) undersize.
* "P" indicates all connecting rod journals are .010" (.25 mm) undersize.

REMOVAL & INSTALLATION

ENGINE REMOVAL

See ENGINE REMOVAL in this section.

INTAKE & EXHAUST MANIFOLD (4.0L)

WARNING: Fuel system is under pressure. Use care when removing fuel lines to prevent personal injury.

Removal

1) Disconnect negative battery cable. Remove air inlet from throttle plate assembly. Disconnect throttle, cruise control and throttle valve (A/T models) cables (if equipped).

2) Disconnect and mark all vacuum and electrical connectors

from intake manifold. Disconnect fuel lines at fuel rail. Fuel lines are removed by squeezing the 2 retaining tabs against the fuel line and pulling the fuel line from the connector. Use caution as these fuel lines are under pressure.

3) Loosen drive belt tensioner and remove drive belt. Remove power steering pump and bracket from intake manifold. Remove fuel rail retaining bolts. Remove fuel rail and injector assembly.

4) Remove intake manifold heat shield. Disconnect EGR tube fittings. Disconnect exhaust pipe from manifold. Disconnect oxygen sensor. Remove retaining bolts and remove manifolds.

Installation

1) Install new gasket. Install exhaust and intake manifolds and loosely install bolts. Install EGR tube between manifolds. Tighten manifold bolts in proper sequence see Fig. 1. Tighten to specifications, see TORQUE SPECIFICATIONS TABLE in this article.

2) Tighten EGR tube bolts. Apply anti-seize to oxygen sensor threads prior to installation. Reverse removal procedures for remaining components. Tighten bolts to specification.

3) Install new "O" rings on fuel line connectors prior to installation. Ensure "CLICK" sound is heard when installing fuel lines. This indicates that fuel lines are properly seated.

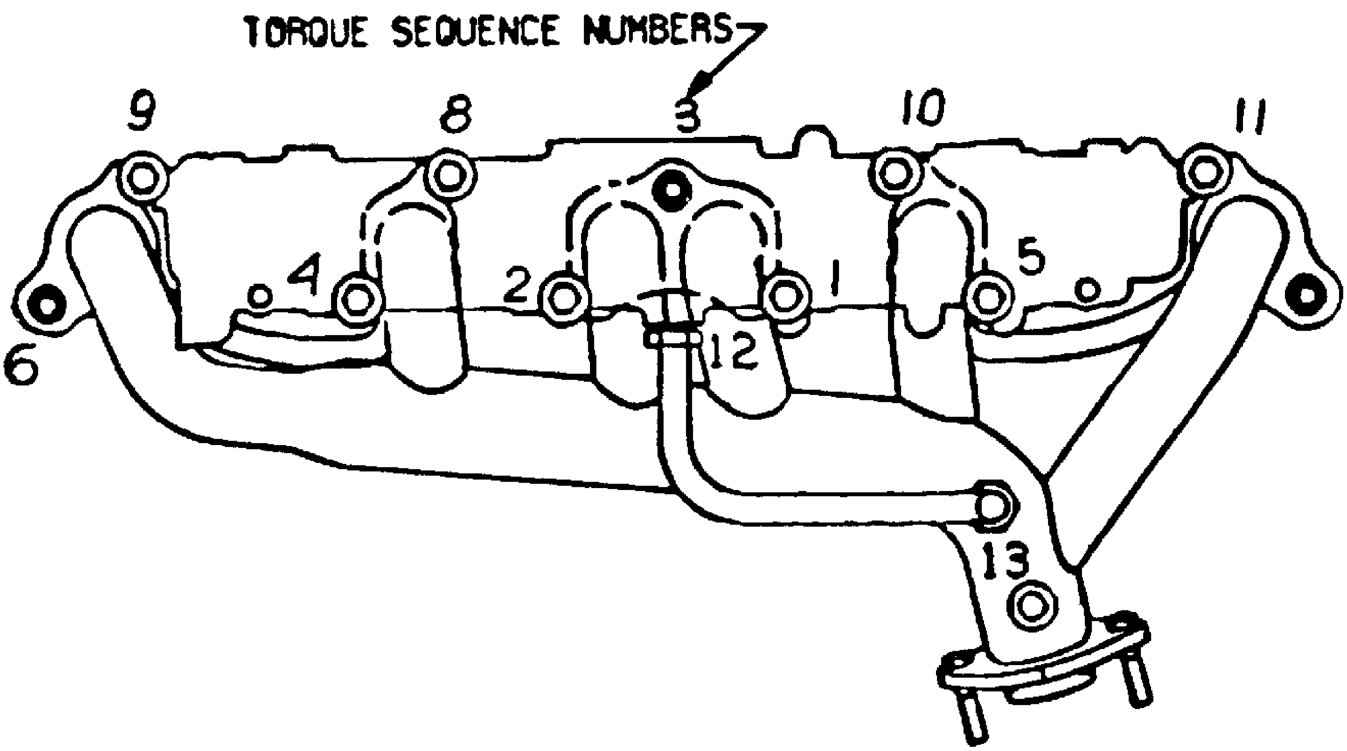


Fig. 1: Manifold Tightening Sequence (4.0L)
Courtesy of Chrysler Motors.

INTAKE & EXHAUST MANIFOLD (4.2L)

Removal

1) Remove air cleaner. Disconnect fuel line at carburetor. Mark and disconnect all vacuum hoses, ventilation hoses and electrical connectors at intake manifold.

2) Disconnect throttle cable at bellcrank. On A/T models, disconnect throttle valve rod. On all models, remove PCV hose from manifold. Drain cooling system. Remove coolant hoses from intake

manifold.

3) Remove EGR tube fittings from manifolds. Remove power steering pump and A/C compressor and mounting brackets (if equipped).

4) Remove intake manifold bolts. Remove intake manifold. If exhaust manifold requires removal, disconnect exhaust pipe from manifold. Remove oxygen sensor (if equipped). Remove exhaust manifold.

Installation

1) Install new gasket. Install exhaust manifold and loosely install bolts. Install intake manifold. Tighten bolts to specification in proper sequence. See Fig. 2.

2) Apply anti-seize to oxygen sensor threads prior to installation. Reverse removal procedure for remaining components. Tighten bolts to specification. Fill and purge cooling system. See COOLING SYSTEM AIR PURGE under WATER PUMP in this article.

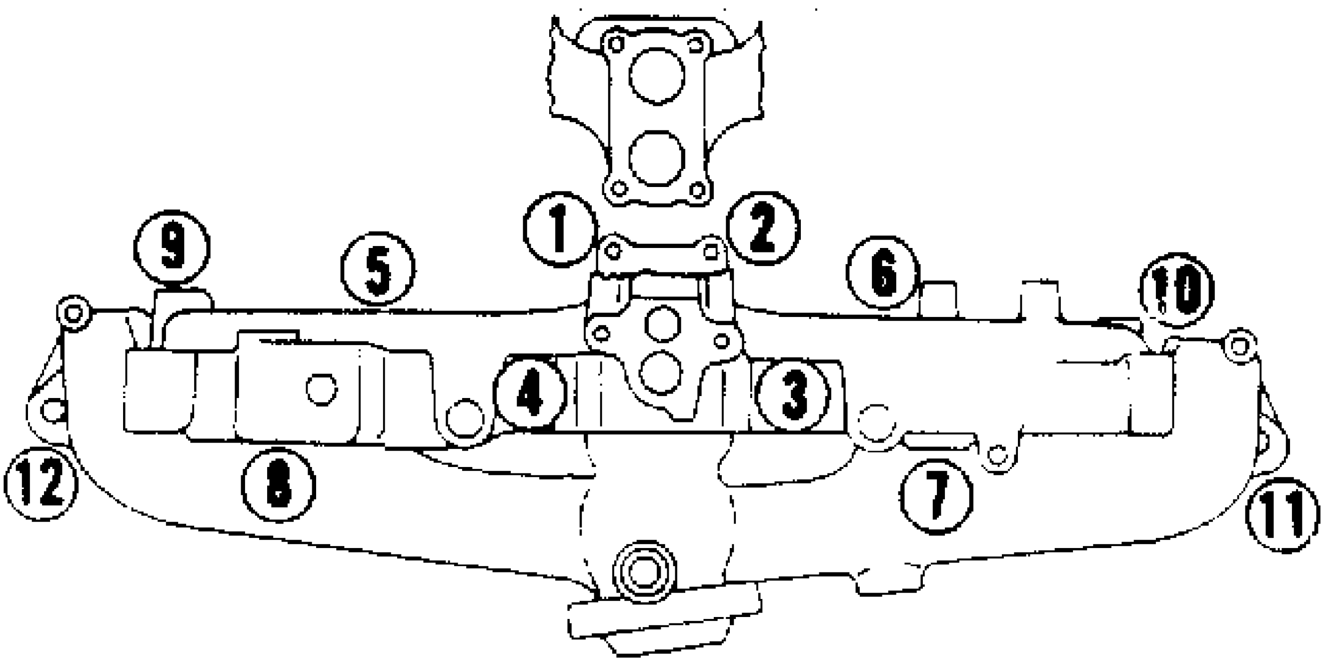


Fig. 2: Manifold Tightening Sequence (4.2L)
Courtesy of Chrysler Motors.

CYLINDER HEAD

Removal

1) Disconnect negative battery cable. Drain cooling system. Disconnect hoses at thermostat housing. Remove intake and exhaust manifolds. See the following:

* INTAKE & EXHAUST MANIFOLD (4.0L).
* INTAKE & EXHAUST MANIFOLD (4.2L).

2) Disconnect and mark all hoses and electrical connections at cylinder head. Disconnect and mark spark plug wires. Remove spark plugs. Remove valve cover bolts.

3) Remove the rocker arms and the push rods. Remove cylinder head bolts. Remove cylinder head. See ROCKER ARMS & BRIDGE.

Inspection

Inspect cylinder head for cracks or damage. Using straightedge, check cylinder head for warpage in several areas. Repair

or replace cylinder head if warpage exceeds .002" (.05 mm) per each 6" (152 mm) or damage exists.

Installation

1) Ensure all gasket surfaces are clean. Clean carbon from combustion chambers and tops of pistons. Apply sealant to both sides of new cylinder head gasket. Install new gasket with the word "TOP" upward. Ensure all holes are aligned.

2) Install cylinder head. Apply sealing compound to threads of cylinder head bolt No. 11 prior to installation. See Fig. 3. Install head bolts.

3) Tighten all bolts in sequence (except No. 11) to 110 ft. lbs. (149 N.m) on 4.0L or 85 ft. lbs. (115 N.m) on 4.2L models. Tighten No. 11 head bolt to 100 ft. lbs. (136 N.m) on 4.0L or 75 ft. lbs. (136 N.m) on 4.2L. See Fig. 3.

4) Reverse removal procedure for remaining components. Install valve cover and new gasket. Tighten bolts to specification.

5) Refill and purge cooling system. See COOLING SYSTEM AIR PURGE under WATER PUMP in this article.

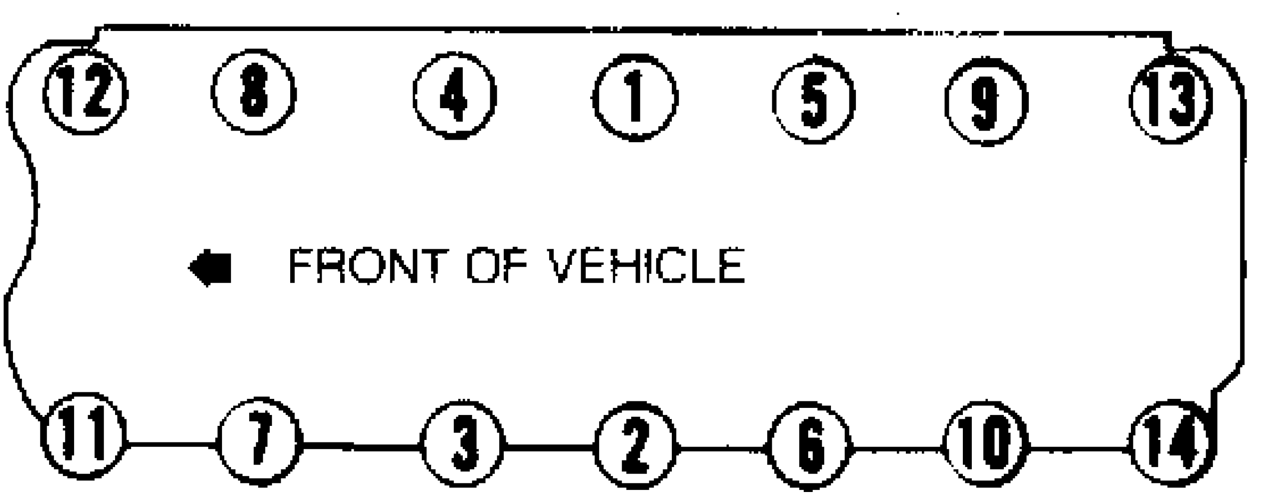


Fig. 3: Cylinder Head Bolt Tightening Sequence
Courtesy of Chrysler Motors.

Valve Arrangement

E-I-I-E-I-E-E-I-E-I-I-E (Front-to-rear).

ROCKER ARMS & BRIDGE

Removal

1) Remove PCV valve hose at valve cover. Remove cruise control servo (if equipped). Remove valve cover. Alternately loosen each rocker arm bolt one turn at a time.

2) Remove rocker arm assemblies and push rods. Mark components for reassembly. Components must be installed in original location.

Installation

Reverse removal procedure. Install rocker arm components in original location. Install valve cover and new gasket. Tighten bolts to specification.

Valve Guide

Valve guides are not replaceable. If clearance is excessive, valve guides must be reamed to accommodate oversized stem valves.

VALVE SPRING

Valve springs can be removed without removing cylinder head.

Valve Spring Installed

For 4.0L the Valve Spring Installed Height Specification is 1.625 inches or 41.29 mm. For the 4.2L the information is not available from manufacturer.

HYDRAULIC VALVE LIFTER

Removal

Remove cylinder head. See CYLINDER HEAD. Using Lifter Remover/Installer (J-21884), remove lifter. Mark lifter location for reassembly reference. Replace lifters as an assembly if damaged. Internal components cannot be interchanged.

Inspection

Inspect lifter and camshaft mating surfaces for wear. Check cylinder block lifter bore diameter. Lifter bore diameter should be within .9055-.9065" (22.999-23.025 mm). Replace parts as necessary.

Installation

Soak lifter assembly in engine oil prior to installation. Reverse removal procedure for installation. Install lifter in original location.

ENGINE FRONT COVER

Removal

1) Disconnect negative battery cable. Remove drive belts, fan and hub assembly. Remove pulley from vibration damper. Remove vibration damper retaining bolt and washer.

2) Using Puller (J-21719-01), remove vibration damper and key. Remove alternator and A/C compressor bracket (if equipped). Remove oil pan-to-front cover bolts. Remove cover-to-block retaining bolts. Remove front cover.

3) Cut oil pan gasket tabs even with face of cylinder block. Remove tabs. Remove gasket from oil pan. Pry crankshaft oil seal from cover.

Installation

1) Ensure all gasket surfaces are clean. Ensure oil slinger is installed on crankshaft. Apply sealing compound on both sides of front cover gasket. Install gasket on cylinder block. Replace front section of oil pan seal with similar section fabricated from new seal.

2) Coat seal with RTV sealant and place in position. Apply sealant to the joint area of oil pan and cylinder block. Apply engine oil on seal-to-oil pan contact areas.

3) Place front cover on cylinder block. Place Front Cover Seal Installer (J-22248) in front cover seal area. Install all retaining bolts. Tighten bolts to specification.

4) Install front cover oil seal. See FRONT COVER OIL SEAL in this article. Remove front cover seal installer. Reverse removal procedure for remaining components. Lubricate vibration damper retaining bolt with oil prior to installation. Tighten bolts to specification.

FRONT COVER OIL SEAL

1) Remove vibration damper. Pry seal from front cover. Use

care not to damage seal area. Position new seal on Front Cover Seal Installer (J-22248) with lip facing outward.

2) Apply sealant to seal outer diameter. Lightly coat crankshaft with oil. Place front cover seal installer on front of crankshaft. Tap seal into front cover. Lightly coat seal contact area of vibration damper with oil.

3) Install key in crankshaft (if removed). Install vibration damper. Lubricate vibration damper bolt with oil. Install retaining bolt and washer. Tighten to specification.

TIMING CHAIN & SPROCKET

Removal

1) Drain cooling system. Remove radiator. Remove engine front cover. See ENGINE FRONT COVER in this article. Remove oil slinger. Rotate crankshaft until timing marks on sprockets are aligned. See Fig. 4.

2) Remove camshaft sprocket bolt. Remove timing chain and both sprockets as an assembly.

Installation

Install timing chain and sprockets. Ensure timing marks are aligned. See Fig. 4. Install camshaft sprocket bolt. Tighten bolts to specification. Install new front cover oil seal. Reverse removal procedure for remaining components.

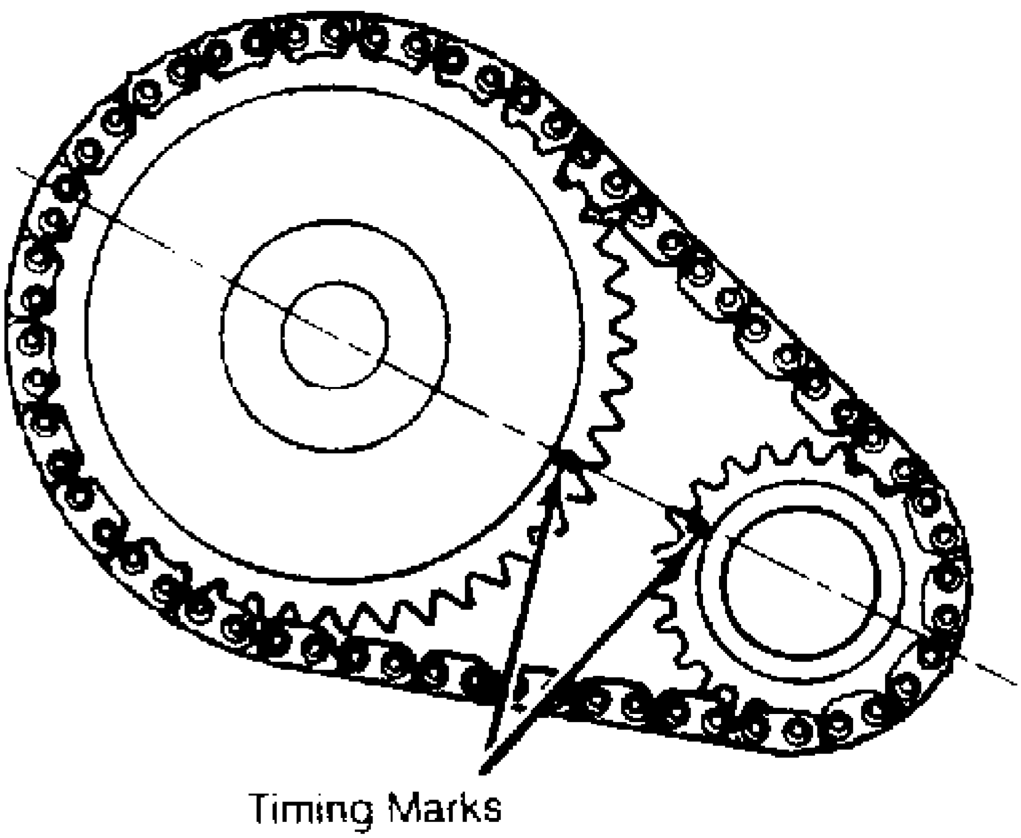


Fig. 4: Timing Chain & Sprocket Alignment
Courtesy of Chrysler Motors.

CAMSHAFT

Removal

1) Drain cooling system. Remove radiator. Discharge A/C system if necessary. Remove A/C condenser and receiver assembly (if equipped). Remove fuel pump (if equipped with mechanical pump), ignition wires and distributor.

2) Remove cylinder head. See CYLINDER HEAD in this article. Remove hydraulic lifters. Using Lifter Remover/Installer (J-21884), remove lifters. Mark lifter location for reassembly reference.

3) Remove engine front cover. See ENGINE FRONT COVER in this article. Remove timing chain and sprockets. Remove front bumper and grille (if necessary). Carefully remove camshaft.

Inspection

Inspect camshaft for flaking, lobe wear or worn bearing journals. Replace if not within specification. See ENGINE SPECIFICATIONS tables.

Installation

Lubricate camshaft and install into place. Use care not to damage camshaft bearings. Reverse removal procedure to complete installation. Tighten bolts to specification.

Camshaft Bearing

Replace camshaft bearings using camshaft bearing remover/installer. Ensure oil holes are aligned after installation.

OIL PAN

See OIL PAN REMOVAL at end of ENGINE section.

PISTON & ROD

NOTE: Mark piston cylinder location for reassembly reference. Install pistons in original cylinder location.

Removal

1) Remove cylinder head. See CYLINDER HEAD in this article. Remove oil pan. See OIL PAN REMOVAL at end of ENGINE section. Remove ridge or deposits from cylinder bore.

2) Mark connecting rod and piston for cylinder identification. Remove bearing cap. Remove piston and rod assembly.

CAUTION: Arrows on top of piston must point toward front of engine. Oil squirt holes in connecting rod must face camshaft side of engine.

Installation

1) Ensure ring end gap and side clearance are within specification. See ENGINE SPECIFICATIONS tables. Install rings on piston. Position ring end gaps at specified areas. See Fig. 5. Ring gaps may vary 20 degrees from positions illustrated.

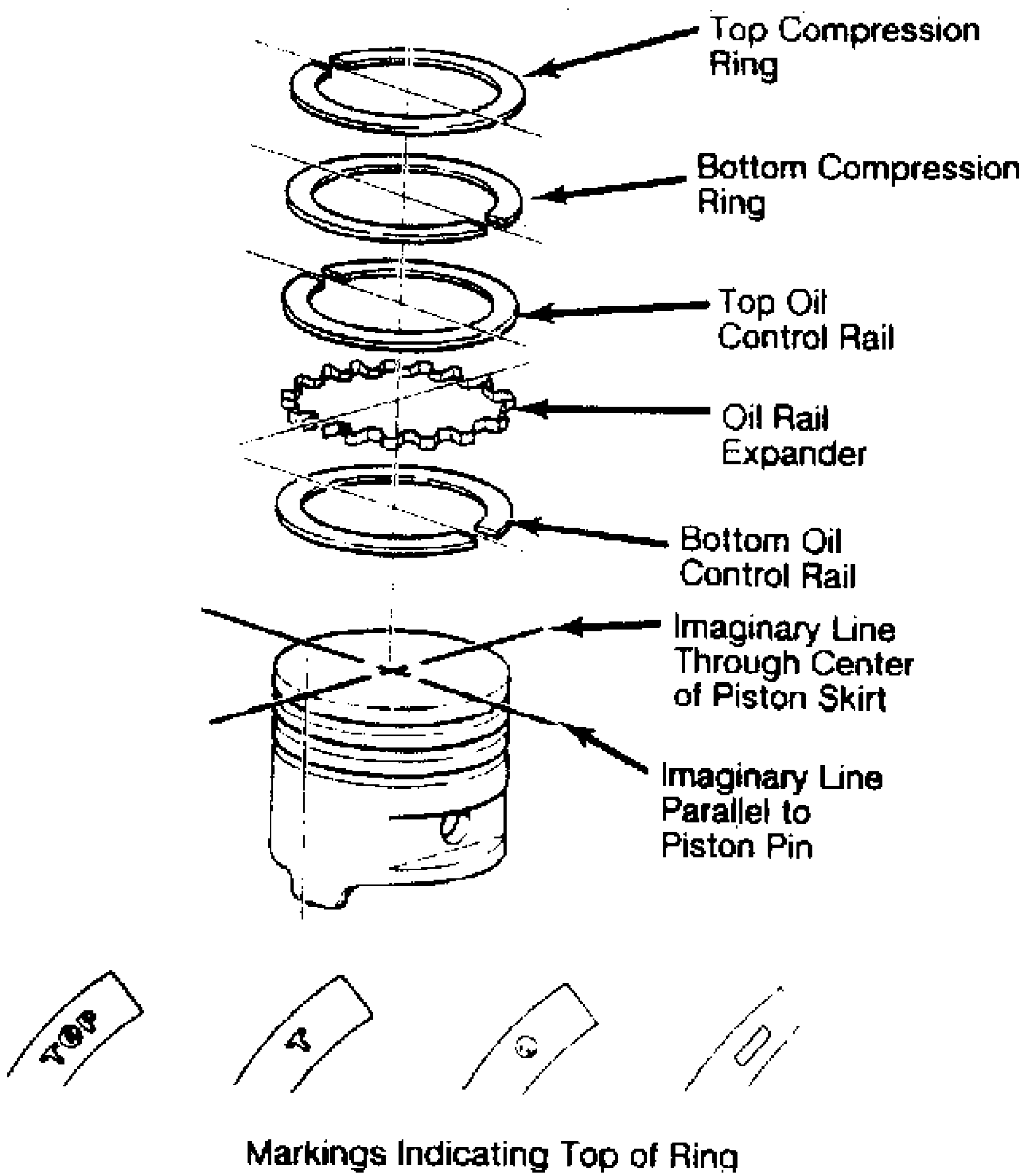


Fig. 5: Positioning Piston Ring Gaps
Courtesy of Chrysler Motors

2) Lubricate piston assembly and cylinder block. Install piston assembly. Arrows on top of piston must face toward front of engine and connecting rod oil squirt hole should face camshaft side of

engine.

3) Install bearings. Check oil clearance and connecting rod side play clearance. Reverse removal procedure for remaining components. Tighten bolts to specification.

Fitting Pistons

1) Determine cylinder taper, wear and out-of-roundness and piston clearance. For cylinder specifications, see CYLINDER, PISTON & ROD SPECIFICATIONS table. If taper or out-of-roundness are not within specification, hone or bore cylinders for installation of new pistons.

2) Measure piston at right angle of the piston pin at the center line of the pin. Compare reading to cylinder bore to determine clearance. Mark fitted piston for cylinder location.

CYLINDER, PISTON & ROD SPECIFICATIONS TABLE

Application	In. (mm)
Connecting Rod	
Crankshaft Bore	2.2080-2.2085 (56.083-56.095)
Pin Bore	.9288-.9298 (23.591-23.616)
Cylinder Bore	
Diameter	
4.0L	3.8751-3.8775 (98.427-98.488)
4.2L	3.7501-3.7533 (95.252-95.334)
Out-of-Round	.001 (.02)
Taper	.001 (.02)
Piston Pin Bore Diameter	.9308-.9313 (23.642-23.655)
Piston Pin Diameter	.9304-.9309 (23.632-23.644)
Piston-to-Cylinder Clearance	.0009-.0017 (.022-.043)

PISTON PIN

NOTE: Note direction of arrows on piston and oil squirt hole in connecting rod location prior to removal.

Removal

Position piston on Support (J-21872-1), Pin Pilot (J-21872-2) and Driver (J-21872-3) on an arbor press. See Fig. 6. Note location of piston pin through gauge window. Press piston pin from piston.

NOTE: Piston and pin must be at standard room temperature when measuring fit. Piston pin should gravity-fall through the piston at room temperature. Piston pin cannot be reused after removal.

Inspection

Measure piston pin diameter, piston bore and connecting rod bores. Replace components if not within specification. See CYLINDER, PISTON & ROD SPECIFICATIONS table.

NOTE: Rod must be positioned on the piston so the oil squirt hole faces the camshaft side of the engine when piston is installed with arrow toward the front of the engine.

Installation

1) Insert pin pilot through piston and connecting rod. Place assembly on support. Insert piston pin through the upper piston pin bore and into connecting rod pin bore. See Fig. 6.

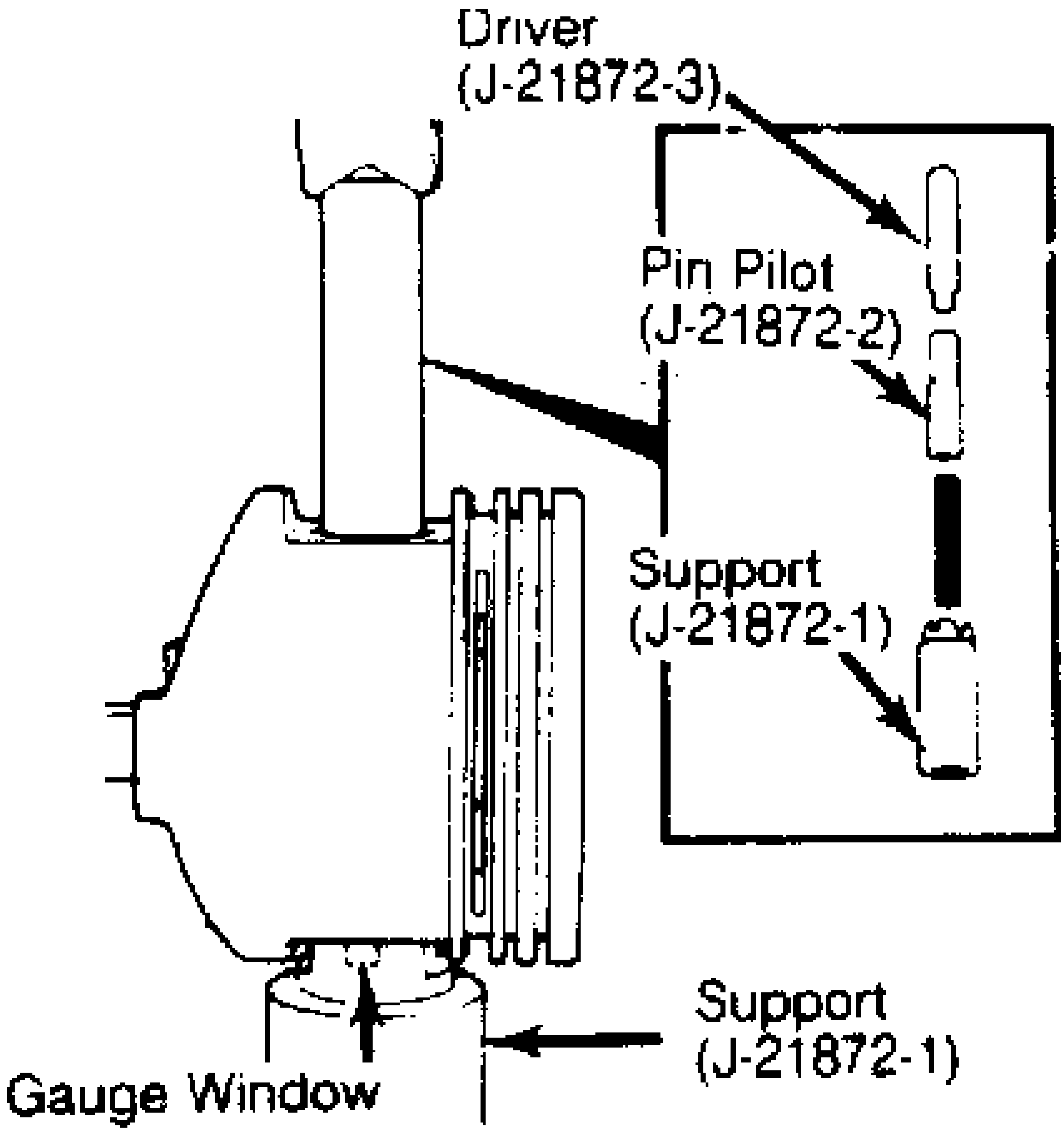


Fig. 6: Piston Pin Removal & Installation
Courtesy of Chrysler Motors.

2) Position driver inside pin. Using arbor press, press pin through rod and piston bores until pilot indexes with mark on support. Remove piston and connecting rod. Pin should be centered in rod ± .0312" (.792 mm).

3) Piston pin installation requires a 2000 lb. (906 kg) press fit. Replace connecting rod if noticeably less effort is encountered.

ROD BEARING

NOTE: Crankshaft journal diameters are indicated by a color coded mark placed on the adjacent counterweight or cheek toward the flanged (rear) end of crankshaft. Note color code to determine proper bearing usage. Check oil clearance after bearing installation.

Removal

Remove oil pan. See OIL PAN REMOVAL at end of ENGINE section. Rotate crankshaft to position rod to be serviced at bottom of stroke. Mark bearing cap and connecting rod. Remove bearing cap with bearing. Push piston and rod assembly up to remove upper bearing.

Installation

1) Note color code on edge of bearings removed. Install bearings. Using Plastigage method, check bearing clearances. Replace bearings as necessary to obtain correct clearance. Bearings are available in standard and undersize application.

2) If required, different sized upper and lower bearings may be installed to obtain correct oil clearance. Tighten bolts to specification. Check rod side play. Rotate crankshaft to ensure freedom of movement. Reverse removal procedure for remaining components. Tighten bolts to specification.

NOTE: Avoid combining bearing inserts in excess of .001" (.02 mm) difference in size.

MAIN BEARING

Removal

Remove oil pan. See OIL PAN REMOVAL at end of ENGINE section. Ensure main bearing caps are marked for location. Remove bearing cap. Rotate crankshaft to remove bearings. Note color code on edge of bearing.

NOTE: Crankshaft main bearing journal diameters are indicated by a color code. Color code is placed on the adjacent cheek toward the flanged (rear) end of crankshaft for all except the rear main. Rear main is color coded on the rear flange. Note color code to determine proper bearing usage. Check oil clearance after bearing installation.

Installation

1) Note color code on edge of bearings removed. Install bearings. Ensure caps are installed in original location with arrow on cap facing toward front of engine. Using Plastigage method, check bearing clearances.

2) Replace bearings as necessary to obtain correct clearance. Bearings are available in standard and undersize applications. If required, different sized upper and lower bearings may be installed to obtain correct oil clearance.

NOTE: If different sized bearings are used, odd sized bearings must all be uniform in location (upper or lower). DO NOT use bearings with a thickness difference exceeding .001" (.02 mm).

3) Tighten bolts to specification. Check crankshaft end play. See CRANKSHAFT END PLAY in this article. Rotate crankshaft to ensure freedom of movement. Reverse removal procedure for remaining components. Tighten bolts to specification.

Crankshaft End Play

1) Using dial indicator, check crankshaft end play. Inspect crankshaft thrust surfaces or thrust bearing for wear if not within specification. See ENGINE SPECIFICATIONS table.

2) Replace thrust bearing if required. When replacing thrust bearing, pry crankshaft forward then reward prior to tightening main bearing cap to specification. Recheck end play. Replace crankshaft if not within specification.

REAR MAIN OIL SEAL

Removal

1) Remove oil pan. See OIL PAN REMOVAL in this section. Remove rear main bearing cap. Note direction of seal lip installation. Remove seal from bearing cap. Loosen all remaining main bearing cap bolts.

2) Using a brass drift, tap upper seal around crankshaft until seal protrudes enough to permit removal with pliers. Remove seal.

Installation

1) Clean crankshaft seal surface. Coat seal-to-block contact areas with liquid soap. Lightly coat all seal lips with engine oil. See Fig. 7. Install upper seal into block with lip facing toward front of engine.

2) Apply Silicone sealer on both sides of lower seal tabs. Ensure no sealer is applied on seal lip. Apply liquid soap on seal-to-cap contact surfaces.

3) Install lower seal into bearing cap with lip facing toward front of engine. Ensure seal is firmly seated in bearing cap. Apply Silicone sealer to chamfered edges of bearing cap. See Fig. 7.

CAUTION: DO NOT apply Silicone sealer on cap-to-block contact surfaces. Sealer should only be applied to chamfered edges only.

4) Install rear main bearing cap. Tighten main bearing cap bolts to specification.

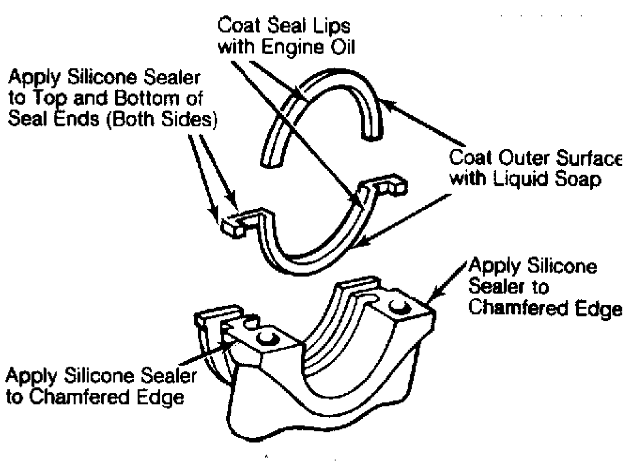


Fig. 7: Installing Rear Main Bearing Oil Seal
Courtesy of Chrysler Motors.

WATER PUMP

Removal

Drain cooling system. Disconnect radiator and heater hoses from pump. Remove drive belt(s). Remove fan shroud. Remove fan assembly. Remove electric cooling fan (if equipped). Remove power steering bracket from water pump. Remove water pump and gasket.

Installation

Ensure gasket surfaces are clean. Install water pump. Tighten bolts to specification. Ensure pump turns freely. Reverse removal procedures. Fill and purge air from cooling system.

NOTE: It may be necessary to remove heater hose to remove trapped air if system cannot be purged using following procedures.

Cooling System Air Purge (Vehicles W/Coolant Recovery)

Fill system to proper level. Place heater control to "HEAT" position and temperature control to "WARM" or "HIGH" position. Install coolant caps. Operate engine to normal operating temperature. Shut off engine and allow system to cool. Add coolant to recovery bottle. Repeat procedure to obtain correct coolant level.

Cooling System Air Purge (Vehicles W/O Coolant Recovery)

Fill system to proper level. Place heater control to "HEAT" position and temperature control to "WARM" or "HIGH" position. Operate engine to normal operating temperature with radiator cap removed. Add necessary coolant and install radiator cap.

NOTE: For further information on cooling systems, see appropriate article in the ENGINE COOLING section.

LUBRICATION

CRANKCASE CAPACITY

Crankcase capacity for 4.0L is 5 1/2 qts. (5.2L) or 5 qts. (4.7L) for 4.2L with oil filter change.

NORMAL OIL PRESSURE

Normal oil pressure should be 37-75 psi (2.6-5.3 kg/cm^2) maximum above 1600 RPM. Minimum oil pressure should be 13 psi (.9 kg/cm^2) at 600 RPM.

OIL PRESSURE REGULATOR VALVE

Oil pressure regulator valve is located in pump body. Valve is nonadjustable and serviced as an assembly.

ENGINE OILING SYSTEM

Engine lubrication is provided by the distributor driven gear-type oil pump. Oil is supplied through the full-flow oil filter and into an internal oil passage. Internal passage provides oil to the lifter bores. Oil is then routed to camshaft and crankshaft bearings. Oil is supplied to rocker arms from the hydraulic lifters and through the push rods.

OIL PUMP

Removal

Remove oil pan. See OIL PAN REMOVAL in this section. Remove

oil pump retaining bolts.

CAUTION: DO NOT move oil pick-up pipe in pump body. If oil pick-up pipe is moved, pick-up pipe must be replaced to ensure an airtight seal.

Disassembly & Inspection

1) Disassemble pump. See Fig. 8. Use feeler gauge and straightedge to check gear end clearance. Place straightedge across gears and pump body. Using feeler gauge, determine thickness feeler gauge which fits snugly between straightedge and gears.

2) With gears installed in pump body, insert feeler gauge between gear tooth and inner wall of pump body to check gear-to-body clearance. Rotate gears and measure clearance at each gear tooth.

3) Compare measurements to specification. See OIL PUMP SPECIFICATIONS table. Repair as necessary if not within specifications. Check pressure regulator valve for wear or binding in pump body. Replace components if wear or binding exists.

OIL PUMP SPECIFICATIONS TABLE

Application	In. (mm)
Gear End Clearance	.004-.008 (.10-.20)
Gear-to-Body Clearance	.002-.004 (.05-.10)

CAUTION: If pressure regulator valve is replaced, ensure replacement valve is the same diameter as that removed. Different diameter valves may be used.

Reassembly & Installation

1) Reverse procedures for reassembly and installation. Apply Permatex No. 2 to pick-up pipe prior to installation. Using Pipe Installer (J-21882), install pick-up pipe. Ensure pick-up pipe support bracket is aligned with pump cover bolt.

2) Fill gear cavity with petroleum jelly prior to installing cover. Apply Loctite on pump cover area. Install cover and bolts. Tighten bolts to specification. Check pump gears for freedom of rotation.

3) Install oil pump and new gasket. Tighten retaining bolts to specification.

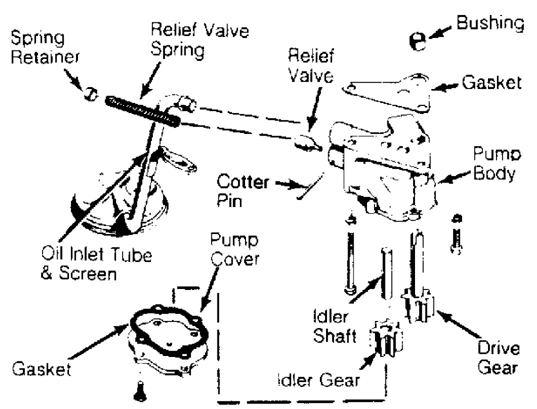


Fig. 8: Exploded View of Oil Pump Assembly
Courtesy of Chrysler Motors.

TORQUE SPECIFICATIONS TABLE

TORQUE SPECIFICATIONS TABLE

Application	Ft. Lbs. (N.m)
Camshaft Sprocket Bolt	80 (109)
Connecting Rod Cap Nut	33 (45)
Crankshaft Pulley-to-Damper Bolt	20 (27)
Cylinder Head Bolt	
4.0L	
No. 11	100 (135)
All Others	110 (149)
4.2L	
No. 11	75 (102)
All Others	85 (115)
Exhaust Pipe-to-Manifold Bolt	20 (27)
Fan & Hub Bolt	18 (24)
Flywheel-to-Crankshaft Bolt	105 (142)
Fuel Rail Bolt	20 (27)
Intake & Exhaust Manifold Bolt	
4.0L	
Exhaust Manifold Bolts 1-5	23 (31)
Exhaust Manifold Bolts 6-7	17 (23)
Exhaust Manifold Bolts 8-11	23 (31)
Exhaust Manifold Bolts 12-13	30 (41)
4.2L	23 (31)
Main Bearing Cap Bolt	
Step 1	40 (54)
Step 2	70 (95)
Step 3	80 (109)
Oil Pump Attaching Bolt	
Short	10 (14)
Long	17 (23)
Oxygen Sensor	35 (47)
Rocker Arm Bolt	19 (26)
Vibration Damper Bolt	(1) 80 (109)
Water Pump Bolts	13 (18)
	INCH Lbs. (N.m)
Engine Front Cover	
Bolt	60 (7)
Studs	192 (22)
Oil Pan Bolt	
1/4" X 20	84 (9)
5/16" X 18	132 (15)
Oil Pump Cover Bolt	70 (8)
Valve Cover Bolt	55 (5)

(1) - Clean and lubricate with oil prior to tightening.

ENGINE SPECIFICATIONS

GENERAL ENGINE SPECIFICATIONS

GENERAL SPECIFICATIONS TABLE

Application	In. (mm)
4.0L	
Displacement	

Cu. In.	242
Liters	4.0
Fuel System	MPI
HP@RPM	173 @ 2500
Torque Ft. Lbs.@RPM	220 @ 2500
Compression Ratio	9.2:1
Bore	3.88 (98.4)
Stroke	3.44 (87.4)
4.2L	
Displacement	
Cu. In.	258
Liters	4.2
Fuel System	2-Bbl.
HP@RPM	112 @ 3000
Torque Ft. Lbs.@RPM	210 @ 2000
Compression Ratio	9.2:1
Bore	3.75 (95.3)
Stroke	3.90 (98.9)

VALVE SPECIFICATIONS

VALVES SPECIFICATIONS TABLE

Application	In. (mm)
4.0L	
Intake	
Head Diameter	1.91 (48.51)
Face Angle	45°
Seat Angle	44.5°
Seat Width	.040-.060 (1.02-1.52)
Stem Diameter	.312 (7.92)
Stem Clearance	.001-.003 (.03-.08)
Valve Lift	.424 (10.76)
Exhaust	
Head Diameter	1.50 (38.10)
Face Angle	45°
Seat Angle	44.5°
Seat Width	.040-.060 (1.02-1.52)
Stem Diameter	.312 (7.92)
Stem Clearance	.001-.003 (.03-.003)
Valve Lift	.424 (10.76)
Valve Spring Height Installed	1.625 (41.29)
4.2L	
Intake	
Head Diameter	1.78-1.79 (45.3-45.5)
Face Angle	29°
Seat Angle	30°
Seat Width	.040-.060 (1.02-1.52)
Stem Diameter	.3715-.3725 (9.44-9.46)
Stem Clearance	.001-.003 (.03-.08)
Valve Lift	.405 (10.29)
Exhaust	
Head Diameter	1.40-1.41 (35.6-35.8)
Face Angle	44°
Seat Angle	44.5°
Seat Width	.040-.060 (1.02-1.52)
Stem Diameter	.3715-.3725 (9.44-9.46)
Stem Clearance	.001-.003 (.03-.08)
Valve Lift	.405 (10.29)
Valve Spring Height Installed	(1)

(1) - Specification not provided from manufacturer.

PISTON/PIN/RING SPECIFICATIONS

PISTONS, PINS & RINGS TABLE

Application	In. (mm)
Piston Clearance	.0009-.0017 (.023-.043)
Pins	
Piston Fit	.0003-.0005 (.008-.013)
Rod Fit	Press Fit
Rings	
Ring No. 1 & No. 2	
End Gap	.010-.020 (.25-.51)
Side Clearance	.0017-.0032 (.043-.081)
Ring No. 3	
End Gap	.010-.025 (.25-.64)
Side Clearance	.001-.008 (.03-.020)

BEARING SPECIFICATIONS

CRANKSHAFT MAIN & CONNECTING ROD BEARINGS TABLE

Application	In. (mm)
Main Bearings	
Journal Diameter	2.4996-2.5001 (63.49-63.50)
Clearance	.0010-.0025 (.03-.064)
Thrust Bearing	No. 3
Crankshaft End Play	.0015-.0065 (.038-1.65)
Connecting Rod Bearings	
Journal Diameter	2.0934-2.0955 (53.17-53.23)
Clearance	.001-.003 (.03-.08)
Side Play	.010-.019 (.25-.48)

CAMSHAFT SPECIFICATIONS

CAMSHAFT TABLE

Application	In. (mm)
Clearance	.001-.003 (.03-.08)
Lobe Lift	.253 (6.43)
Journal Diameter	
No. 1	2.029-2.030 (51.54-51.56)
No. 2	2.019-2.020 (51.28-51.31)
No. 3	2.009-2.010 (51.03-51.05)
No. 4	1.999-2.000 (50.77-50.80)

VALVE SPRING SPECIFICATIONS

VALVE SPRINGS TABLE

Application	In. (mm)
4.0L	
Pressure (1)	

Valve Closed	66-74 @ 1.625 (30-34 @ 45.5)
Valve Open	205-220 @ 1.20 (91-100 @ 30.48)
Free Length	1.82 (46.23)
4.2L	
Pressure (1)	
Valve Closed	64-72 @ 1.79 (29-33 @ 45.5)
Valve Open	188-202 @ 1.41 (85-92 @ 35.8)
Free Length	1.99 (50.5)

(1) - Lbs. @ In. (Kg @ mm).

4.0L CEC SYSTEM

1988 Jeep Cherokee

1988 COMPUTERIZED ENGINE Controls
ENGINE CONTROL SYSTEM
JEEP 4.0L MPFI 6-CYLINDER

Cherokee, Comanche & Wagoneer

DESCRIPTION

The 4.0L engine control system controls engine operation to lower exhaust emissions while maintaining good fuel economy and driveability. The system is designed to maintain a 14.7:1 air/fuel ratio under all engine operating conditions. When the ideal air/fuel ratio is maintained, the catalytic converter can control oxides of nitrogen (NOx), hydrocarbon (HC), and carbon monoxide (CO) emissions.

The system consists of the following sub-systems: Fuel Control, Data Sensors and Switches, Electronic Control Unit (ECU), Diagnostics, Electronic Spark Advance, Idle Speed Control, Exhaust Gas Recirculation, and Transmission Shift Light.

OPERATION

FUEL CONTROL

The fuel control system delivers fuel to the engine. Fuel from the in-tank fuel pump flows to the fuel rail, injectors and pressure regulator. The pressure regulator maintains fuel system pressure at 31-39 psi (2.1-2.7 kg/cm^2). Excess fuel is returned to the tank by a fuel return line.

The fuel pump is energized through the fuel pump relay that is located on the right inner fender panel in the engine compartment. Battery voltage is provided through the ignition switch and is energized when the ECU completes the ground path.

The fuel injectors are electrically operated solenoid valves. The ECU determines injector pulse width ("on/off") time based upon engine operating conditions and delivers the proper pulse width to maintain an air/fuel ratio of 14.7:1.

The ECU varies the amount of voltage applied to the injectors to compensate for battery voltage changes. Battery voltage information is provided to the ECU through the wiring harness. No sensor or switch is required.

DATA SENSORS & SWITCHES

Each sensor and/or switch furnishes electronic impulses to the ECM. Based on these input signals, the ECM computes spark timing and air/fuel mixture for proper engine operation.

Coolant Temperature Sensor (CTS)

The CTS is located on the left side of the block, just below exhaust manifold. The sensor provides coolant temperature information to the ECU. Engine coolant temperature is used by the ECU for the following functions:

* Enrich air/fuel mixture for cold engine starts.
* Control idle speed during warm-up.
* Increase spark advance during cold engine operation.
* Prevent EGR flow during cold engine operation.

Manifold Absolute Pressure (MAP) Sensor

The MAP sensor measures changes in intake manifold pressure resulting from engine load and speed changes. The MAP sensor is located in the engine compartment, on the firewall behind the engine. The ECU uses this information to control fuel delivery and ignition timing.

Oxygen (O2) Sensor

The oxygen sensor is mounted in the exhaust manifold to monitor oxygen content of exhaust gases. The oxygen content reacts with the oxygen sensor to produce a voltage output signal which is sent to the ECU.

The oxygen sensor is equipped with a heating element that keeps the sensor at a consistent temperature under warm-up and idle conditions. This allows the engine control system to enter "closed loop" mode of operation much earlier, and to remain in "closed loop" during extended idle periods.

The heating element of the sensor is controlled by the ECU through the O2 sensor heater relay. This is a normally closed relay that supplies voltage to the sensor under warm-up and idle conditions. When the ECU receives information from the MAP and speed sensors indicating that the sensor will stay heated due to exhaust gas temperature, the ECU opens the relay to stop voltage to the heating element.

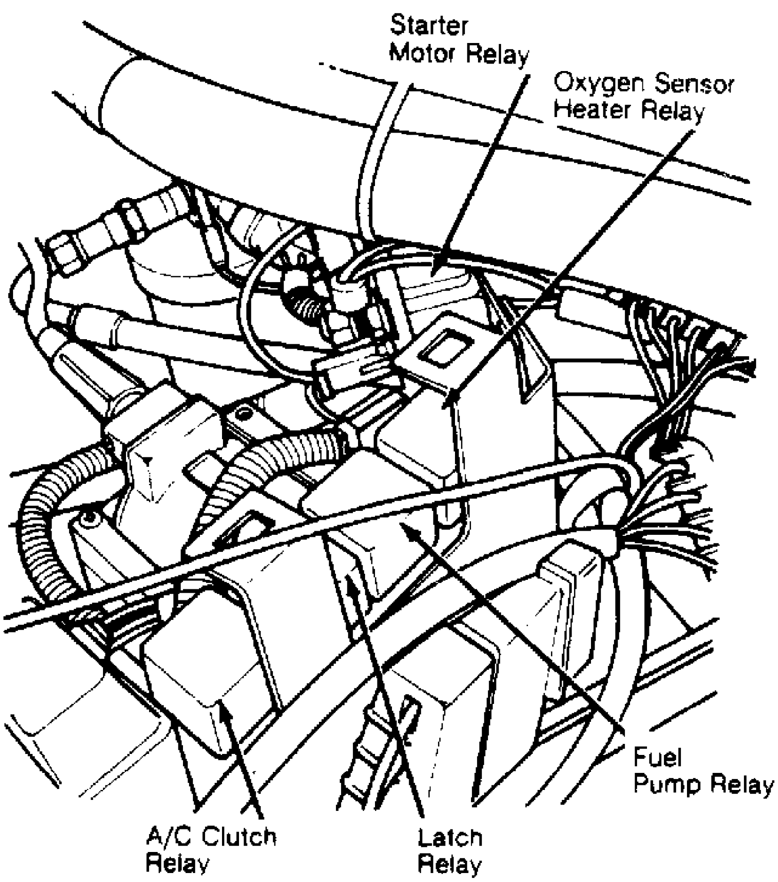


Fig. 1: Location & Identification of 4.0L Relays

Throttle Position Sensor (TPS)

The TPS is a variable resistor connected to the throttle shaft. The sensor is a potentiometer that has one end connected to the

ECU signal line and the other end connected to ground. As throttle valve angle changes, a return voltage is sent back to the ECU through the third wire. Output voltage to the ECU is about one volt when throttle valve is at idle position, and about 5 volts when throttle valve is at wide open throttle.

A dual TPS is used on automatic transmission equipped models. The additional sensor provides throttle position information to the transmission.

Knock Sensor

A knock sensor is mounted on the lower left side of block, just above the oil pan. This sensor detects abnormal engine vibration due to "detonation" and/or "pre-ignition". The knock sensor supplies detonation information to the ECU. The ECU then alters ignition timing as needed to maintain maximum timing under most operating conditions.

Park/Neutral (P/N) Switch

The P/N switch is mounted in automatic transmission equipped vehicles. The switch indicates when the transmission is in Park or Neutral.

Speed Sensor

The speed sensor is a nonadjustable sensor attached to the flywheel/drive plate housing with special shoulder bolts. This sensor provides Top Dead Center (TDC) and engine speed information to the ECU by counting the flywheel teeth as they pass during engine operation. The flywheel has a large trigger tooth and notch located 12 small teeth before each TDC position. See Fig. 2.

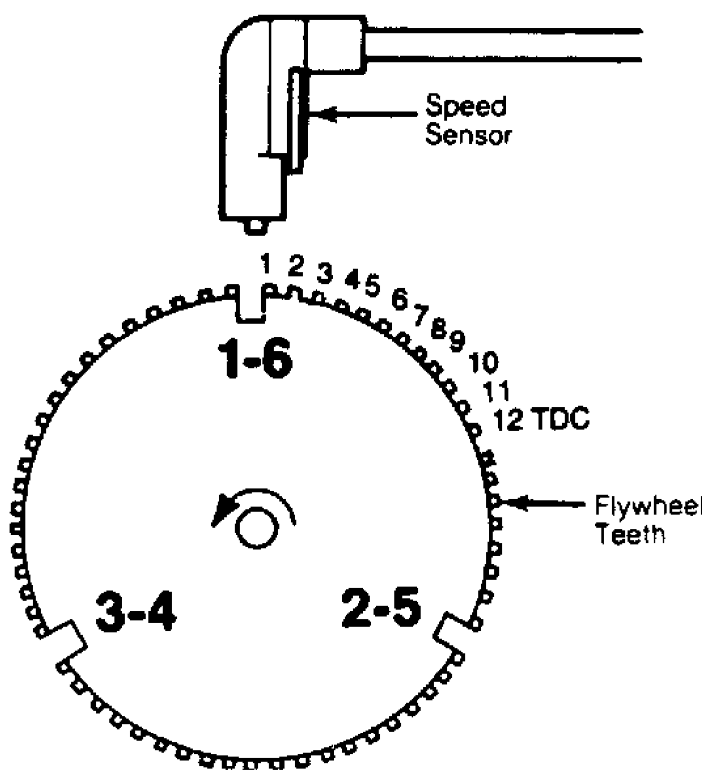


Fig. 2: Design of Speed Sensor

When a small tooth and notch pass the magnetic core of the sensor, the concentration and collapse of the magnetic field created induces a small voltage spike into the sensor pick-up coil windings.

These small voltage spikes give the ECU information for calculating engine speed.

When a large tooth and notch pass the magnetic core of the sensor, the concentration and collapse of the magnetic field created induces a higher voltage spike into the sensor pick-up coil windings. This higher voltage spike indicates to the ECU that a piston will soon be at TDC (12 teeth later).

The ECU uses speed sensor information for advancing or retarding ignition timing, dependent upon input from other sensors and switches.

A/C "ON" Switch

This switch signals the ECU that the A/C system is energized. This signal is used by the ECU to increase idle speed.

Starter Motor Relay

Although no switch or sensor is used, the ECU requires this information for fuel enrichment during starting. This information is passed on the the ECU through the starter motor relay.

Distributor Reference Signal

Although no switch or sensor is used, the ECU requires this information for ignition timing and fuel supply. This information is relayed to the ECU through a "synch pulse" provided by the distributor stator. This allows the ECU to synchronize injector opening with intake valve opening.

ELECTRONIC CONTROL MODULE (ECM)

The Electronic Control Unit (ECU) is the "brain" of the engine control system. The ECU is located in the passenger compartment, under left side of dash to right of steering column.

The ECU senses engine operating conditions, processes input signals, and controls the various systems that affect vehicle performance.

DIAGNOSTICS

The engine control system has diagnostic capabilities. Using System Tester (M.S. 1700), diagnostics can be performed on the system to more accurately determine faulty components. The diagnostic connectors are located in the engine compartment at the right shock tower (or under left side of instrument panel).

NOTE: Information for diagnosing the engine control system using the System Tester (M.S. 1700) was not available from manufacturer. Only component testing is provided.

ELECTRONIC SPARK ADVANCE

Based upon engine operating conditions received from the sensors and switches, the ECU controls spark timing. The ECU triggers the ignition coil through the ignition control module.

IDLE SPEED CONTROL

Idle speed is controlled by the ECU through the idle speed stepper motor. A latch relay is used to program the stepper motor for engine start-up. The relay is located on the right inner fender panel. See Fig. 1. The ECU energizes the latch relay when engine is in cranking mode, and keeps the relay energized for 3-5 seconds after the engine is stopped. In this way, the stepper motor can provide the

proper increased enrichment for the next engine start. Idle speed is nonadjustable.

EMISSION CONTROL

The ECU electrically controls Exhaust Gas Recirculation (EGR). An ECU-controlled solenoid valve is used to control EGR valve function. This valve is located on the left inner fender panel and is operated by the ECU in response to coolant temperature, throttle position, and manifold pressure.

Under conditions of engine warm-up, engine idle, wide open throttle, or rapid acceleration/deceleration, the solenoid valve is energized, blocking vacuum to the EGR valve. At normal operating temperatures with engine speed above idle, the solenoid valve is de-energized, allowing normal EGR valve function.

NOTE: If the electrical connector is removed from the EGR solenoid, EGR flow will be allowed at all times.

A/C CLUTCH CONTROL

The ECU controls the A/C compressor clutch to improve idle quality. The A/C compressor clutch will be engaged or disengaged as deemed necessary by the ECU through the A/C clutch relay.

SHIFT LIGHT CONTROL

The shift light system is used on all manual transmission equipped vehicles. The ECU monitors coolant temperature, throttle position, vehicle speed, and engine speed to control the shift light. The ECU calculates what gear position the vehicle should be in and uses this information to turn on the light. The light indicates the best shift point to the driver for maximum fuel economy.

The light is tested when the ignition switch is turned on. When the engine is started, the light should go out. A transmission-mounted switch prevents the light from illuminating when the transmission is shifted into high gear. The ECU turns the light off if the shift to the next higher gear is not performed within 3-5 seconds after light comes on.

DIAGNOSIS & TESTING

PRELIMINARY CHECKS

Before assuming that the ECU is faulty, the following systems and components must be in good condition and operating properly:

* Air filter.
* All support systems and wiring.
* Battery connections and specific gravity.
* Compression pressure.
* Electrical and vacuum connections to components, sensors and switches.
* Emission control devices.
* Ignition system.
* All vacuum and fuel line (hose) connections.

FUEL SYSTEM TEST

Fuel Pressure

1) Remove cap from pressure test port on fuel rail and

connect Fuel Pressure Gauge (J-34730-1). See Fig. 3. Start engine and observe fuel pressure. With vacuum hose connected to pressure regulator, pressure should be about 31 psi (2.2 kg/cm^2)), and about 39 psi (2.7 kg/cm^2)) with vacuum hose disconnected.

2) If pressure is not as specified, inspect fuel supply and return lines for kinks and obstructions. If fuel lines are okay, replace pressure regulator. Remove gauge and install cap on test port.

Fuel Flow

1) Remove cap from the pressure test port on the fuel rail. See Fig. 3. Connect piece of hose to port and place other end in graduated container of at least one quart (1L) capacity.

2) Pinch off fuel return line. Run fuel pump by placing jumper wire between terminals "D1-5" and "D1-6" of diagnostic connector "D1". If fuel flow is less than one quart (1L) in one minute, replace fuel pump. Remove hose and install test port plug.

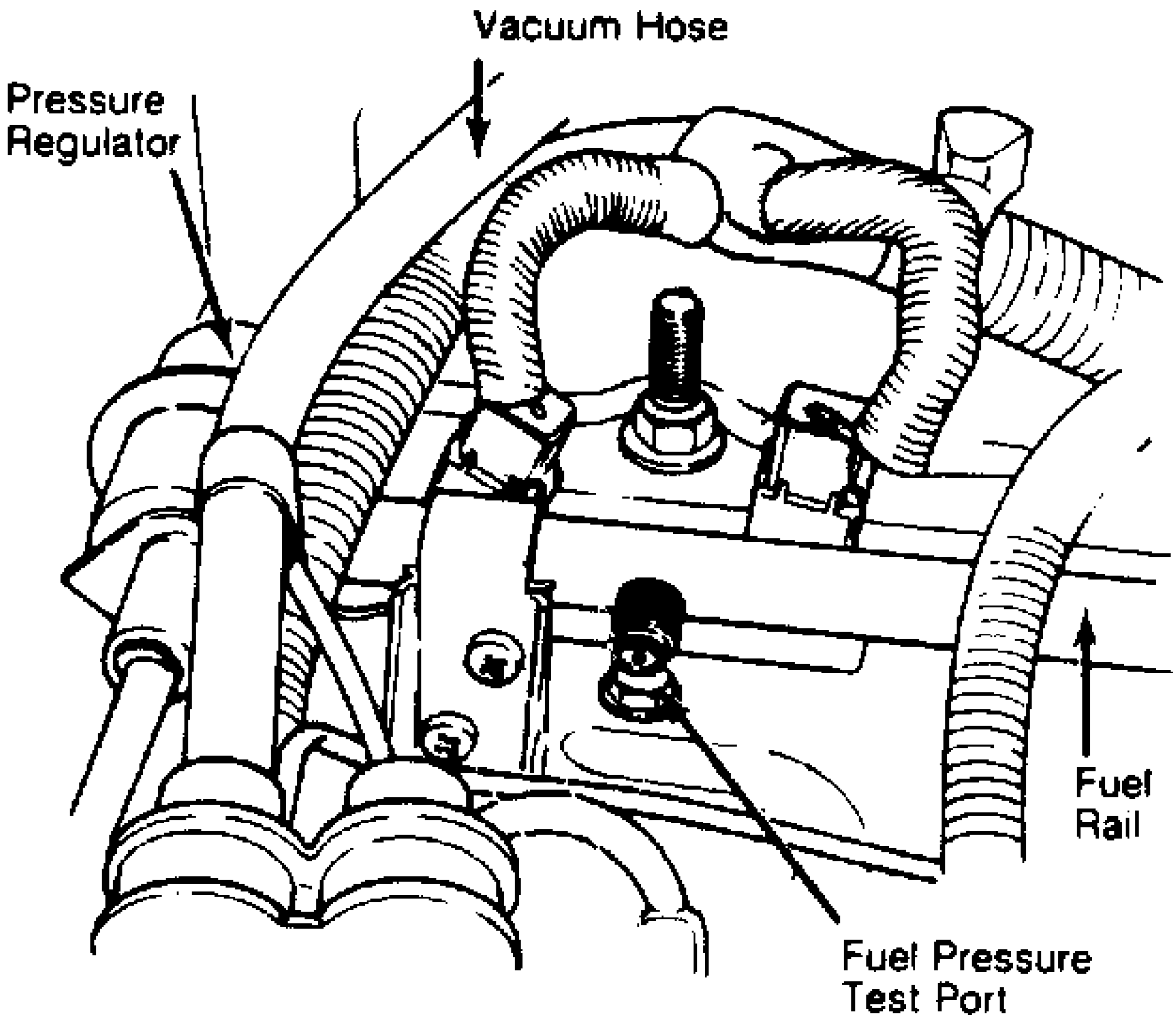


Fig. 3: Location of Fuel Pressure Test Port

Fuel Injector Test

See the FUEL INJECTOR DIAGNOSTICS chart near the end of this article. See Fig. 9

COMPONENT TESTING

Throttle Position Sensor

See THROTTLE POSITION SENSOR DIAGNOSTICS chart near the end of this article. See Fig. 8.

Coolant Temperature Sensor (CTS) &
Manifold Air Temperature (MAT) Sensor

1) Disconnect the electrical connector from the sensor. Using a high impedance, digital volt/ohmmeter, measure the resistance of the sensor. If measured resistance is not as specified, replace sensor. See the CTS & MAT SENSOR TEMPERATURE-TO-RESISTANCE VALUE table.

2) Test electrical harness resistance of both sensors by testing between ECU harness connector "D-3" and sensor connector. Also test between sensor connector and ECU harness connector "C-10" ("C-8" on MAT sensor). Repair wire if open circuit is detected. Repair MAT sensor wiring harness if resistance is greater than one ohm.

CTS & MAT SENSOR TEMPERATURE-TO-RESISTANCE VALUE

°F(°C)	Ohms
212 (100)	185
160 (71)	450
100 (38)	1600
70 (21)	3400
40 (4)	7500
20 (-7)	13,500
0 (-18)	25,000
-40 (-40)	100,700

Manifold Absolute Pressure (MAP) Sensor

NOTE: Terminal identification letters are stamped on MAP sensor body.

1) Disconnect electrical connector from sensor. With ignition on and engine stopped, measure voltage output of sensor terminal "B". See Fig. 4. Ensure wiring harness is okay by also measuring voltage at ECU terminal "C-t". Output voltage should be 4-6 volts at both points. Repair or replace wiring harness as required.

2) With ignition on and engine stopped, measure supply voltage of sensor terminal "C". See Fig. 4. Ensure wiring harness is okay by also measuring voltage at ECU terminal "C-14". Supply voltage should be 4.4-5.5 volts at both points. Repair or replace wiring harness as required.

3) Using an ohmmeter, measure ground circuit resistance at sensor terminal "A" and ECU connector terminal "D-3". Ensure wiring harness is okay by also measuring resistance between ECU terminal "D-3" and "B-11". If ohmmeter indicates an open circuit, check for defective sensor ground connection at right side of cylinder block.

4) If ground connection is okay, replace ECU. If ECU terminal "D-3" has short to 12-volts, repair wire before replacing ECU. Repair or replace wiring harness as required.

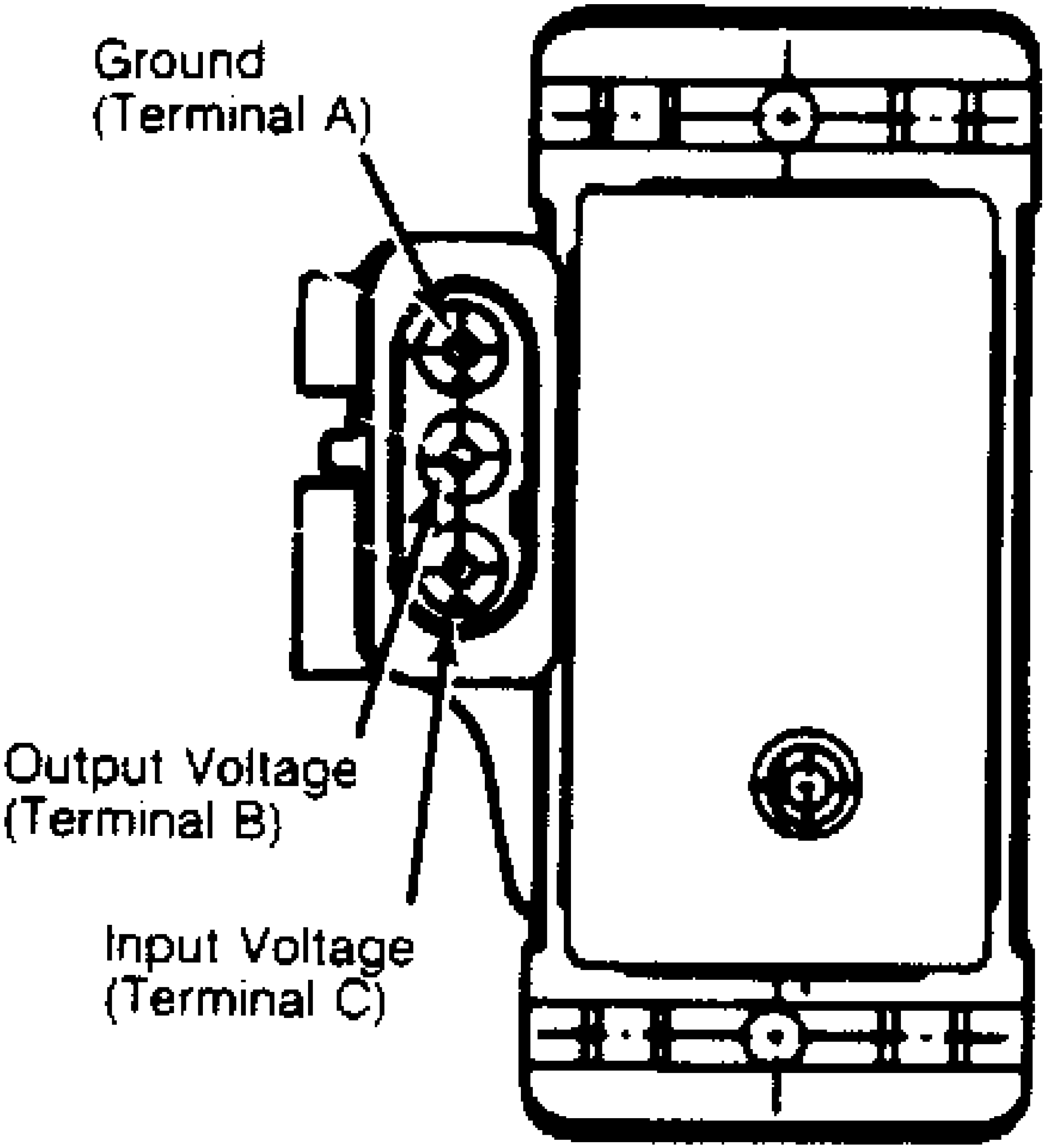


Fig. 4: MAP Sensor Terminal Identification

Oxygen Sensor

Oxygen sensor must be tested with System Tester (M.S. 1700).

Oxygen Sensor Heating Element

Disconnect electrical connector from oxygen sensor. Using an ohmmeter, measure resistance between connector terminals "A" and "B" (marked on connector). See Fig. 5. If resistance is not 5-7 ohms, replace sensor.

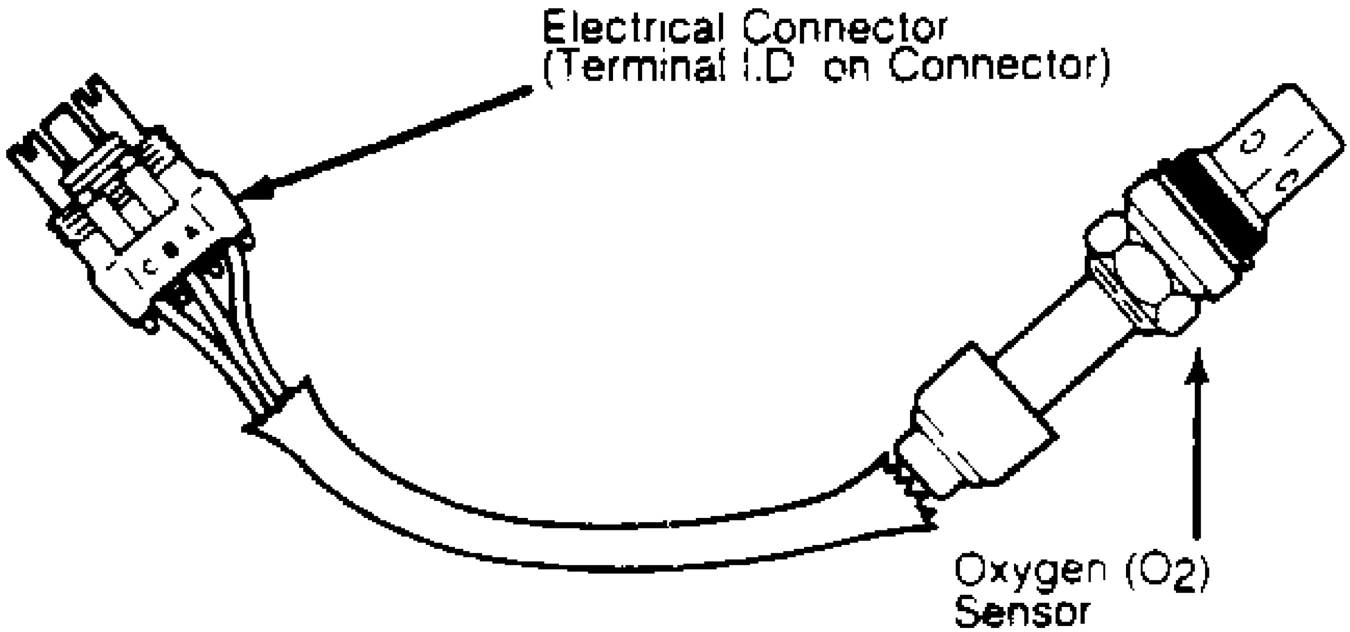


Fig. 5: Testing Oxygen Sensor Heating Element Resistance

Knock Sensor

Knock sensor must be tested with System Tester (M.S. 1700).

Speed Sensor

Disconnect speed sensor electrical connector from the sensor. Using an ohmmeter, measure resistance between connector terminals "A" and "B" (marked on connector). If reading is not 125-275 ohms with engine at normal operating temperature, replace speed sensor.

"Synch Pulse" (Stator)

1) Using an analog voltmeter, insert positive probe into Blue wire at distributor connector. Insert negative probe into Gray wire with tracer at distributor connector.

NOTE: Do not remove connector from distributor. Insert voltmeter leads from rear of connector. Do not puncture wire.

2) With voltmeter set on "15-Volt A/C" scale, turn ignition on. Voltmeter should indicate 5 volts. If voltage is indicated, go to step 4). If no voltage is indicated, check voltmeter leads for good connection and go to next step.

3) If there is still no voltage reading, turn ignition off and remove ECU. Reconnect harness and turn ignition off and remove ECU. Reconnect harness and turn ignition on. Check for voltage between ECU pin "C-16" and good ground. If voltage still does not register, test system with System Tester (M.S. 1700).

4) If 5 volts was detected, check for continuity at the following points:

* Between Blue wire at distributor connector and terminal "C-16" at ECU.
* Between Gray wire with tracer at distributor connector and terminal "C-5" at ECU.
* Between Black wire at distributor connector and good ground.

If no continuity is shown, repair wiring harness. If continuity is shown, reconnect voltmeter as in step 2).

5) While observing voltmeter, crank engine. Voltmeter needle should fluctuate back and forth during engine cranking. This verifies proper operation of distributor stator. If voltmeter needle does not fluctuate, replace stator.

EGR Solenoid Valve

1) Make sure vacuum is present at port "C" of the solenoid. See Fig. 6. Remove vacuum connector from ports "A" and "B" of solenoid. Connect vacuum gauge to port "B". Start engine and run at idle. Vacuum should not be present at port "B".

2) Disconnect electrical connector from solenoid. Vacuum should now be present at port "B". Stop engine. Reconnect electrical connector at solenoid. Remove vacuum gauge and reconnect vacuum hoses.

Relays - General Testing

1) The relays used on the 4.0L engine are all of the same basic construction and design. Terminal No. 30 is usually connected to battery voltage ("switched" or battery positive at all times). Terminal No. 87A is connected to terminal No. 30 in de-energized position.

2) Terminal No. 87 is connected to terminal No. 30 in the energized position. This connection supplies battery voltage to the operated device.

3) Terminal No. 86 is connected to the electromagnet of the operated device; usually through a "switched" power source. Terminal No. 85 is connected to the electromagnet of the operated device; usually grounded through a switch or the ECU.

NOTE: Not all relays have battery voltage applied at terminal No. 30. Some may have battery voltage applied at terminal Nos. 87 or 87A. Check design of relay before testing.

4) When testing relays, there should be continuity between terminal Nos. 87A and 30 when relay is in de-energized position. Resistance between terminal Nos. 85 and 86 should be 70-80 ohms for resistor-type relays and 81-91 ohms for diode-type relays.

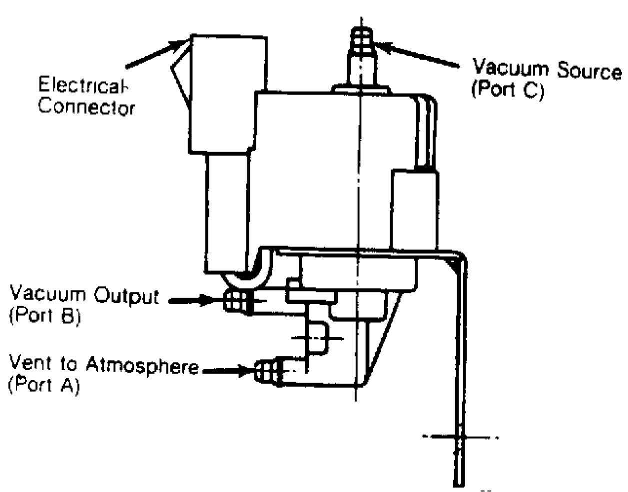


Fig. 6: Testing EGR Solenoid Valve

Starter Motor Relay

1) Disconnect electrical connectors from terminals "I" and "G". Using an ohmmeter, measure resistance between the terminals.

Resistance value should be about 22 ohms. Measure resistance between either terminal and battery negative post. Resistance value should be infinite. If resistance values are not as specified, replace relay. If okay, reconnect electrical connectors.

2) Disconnect electrical connector from "SOL" terminal. Connect voltmeter between terminal and battery negative post. While observing voltmeter, turn ignition switch to "START" position. If 12 volts is not indicated, check and repair wiring harness, bulkhead connector, and/or ignition switch. If battery voltage is present, go to next step.

3) If battery voltage is present, but starter relay does not work, place transmission in Park (Neutral for man. trans.) and apply parking brake. Disconnect electrical connector from terminal "I" (Dark Green wire) and apply battery voltage to terminal. Using a jumper wire, touch terminal "G" to ground. If relay does not click, replace relay. If relay does click, repair ground circuit.

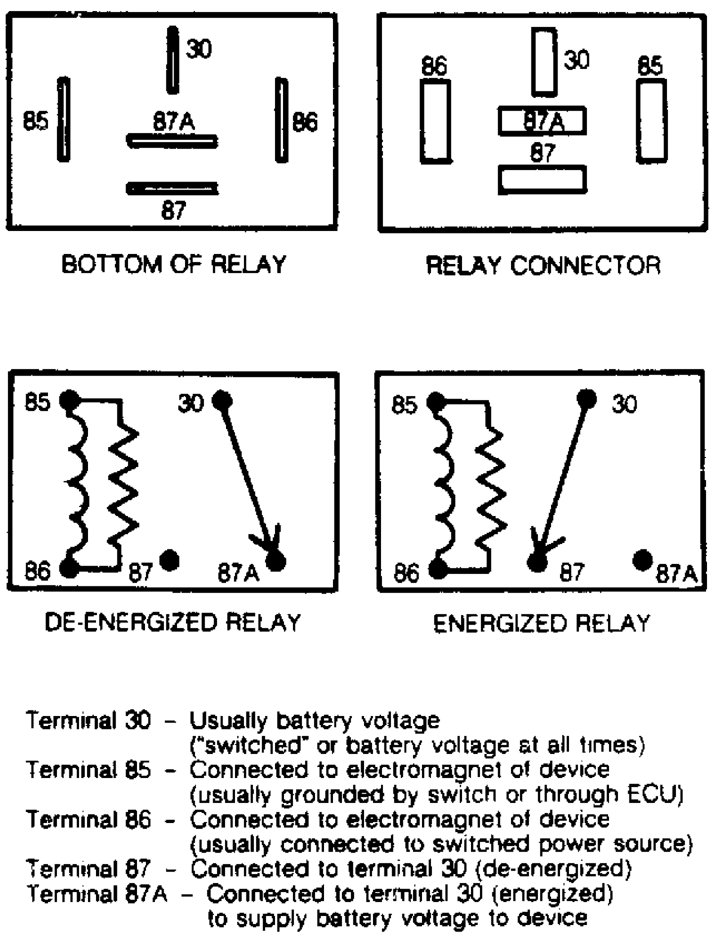


Fig. 7: Design & Function of Relays

REMOVAL & INSTALLATION

ELECTRONIC CONTROL UNIT (ECU)

Removal & Installation

Information not available from manufacturer.

COOLANT TEMPERATURE SENSOR (CTS)

Removal & Installation

Drain cooling system. Remove air cleaner assembly. Disconnect electrical connector and remove sensor from block. To install, reverse removal procedure. Refill cooling system.

OXYGEN (O2) SENSOR

Removal & Installation

Raise and support vehicle. Disconnect electrical connector from sensor. Remove sensor from exhaust manifold. Install and tighten sensor to 35 ft. lbs. (47 N.m). Reconnect electrical connector. Lower vehicle.

THROTTLE POSITION SENSOR (TPS)

Removal

Disconnect electrical connector from TPS. Bend lock tabs away from retaining screws and remove screws. Remove TPS.

Installation

With throttle valve in normal closed position, install TPS. Install TPS retaining screws. Perform OUTPUT CHECK.

NOTE: Throttle position sensor is nonadjustable. Only output voltage can be monitored.

Output Check (Manual Transmission Only)

1) Connect negative lead of digital voltmeter to terminal "B" and positive lead to terminal "A" of TPS connector. Do not disconnect electrical connector. Insert leads through back of connector. It may be necessary to remove throttle body from vehicle to gain access to connector.

2) Turn ignition on, engine off. With throttle closed and resting against idle stop, input voltage should be about 5 volts. Move positive lead from terminal "B" to terminal "C" and read voltage output. Output voltage should be about 0.8 volt with throttle closed and resting against idle stop.

3) If voltage is not as specified, loosen lower retaining screw and pivot sensor for large adjustments. Loosen upper retaining screw and pivot sensor for small adjustments. Adjust sensor so output voltage reading equals 16 percent of input voltage. If voltage specifications cannot be obtained, replace sensor. Remove voltmeter. Tighten screws and bend retaining tabs into position.

ALL OTHER SENSORS, SOLENOIDS & SWITCHES

Removal & Installation

Removal of sensors, switches, and solenoids is accomplished by disconnecting the electrical and/or vacuum connectors and removing or detaching the component. To install, reverse removal procedure.

TESTING

NOTE: Refer to Figs. 8-10 for Testing information.

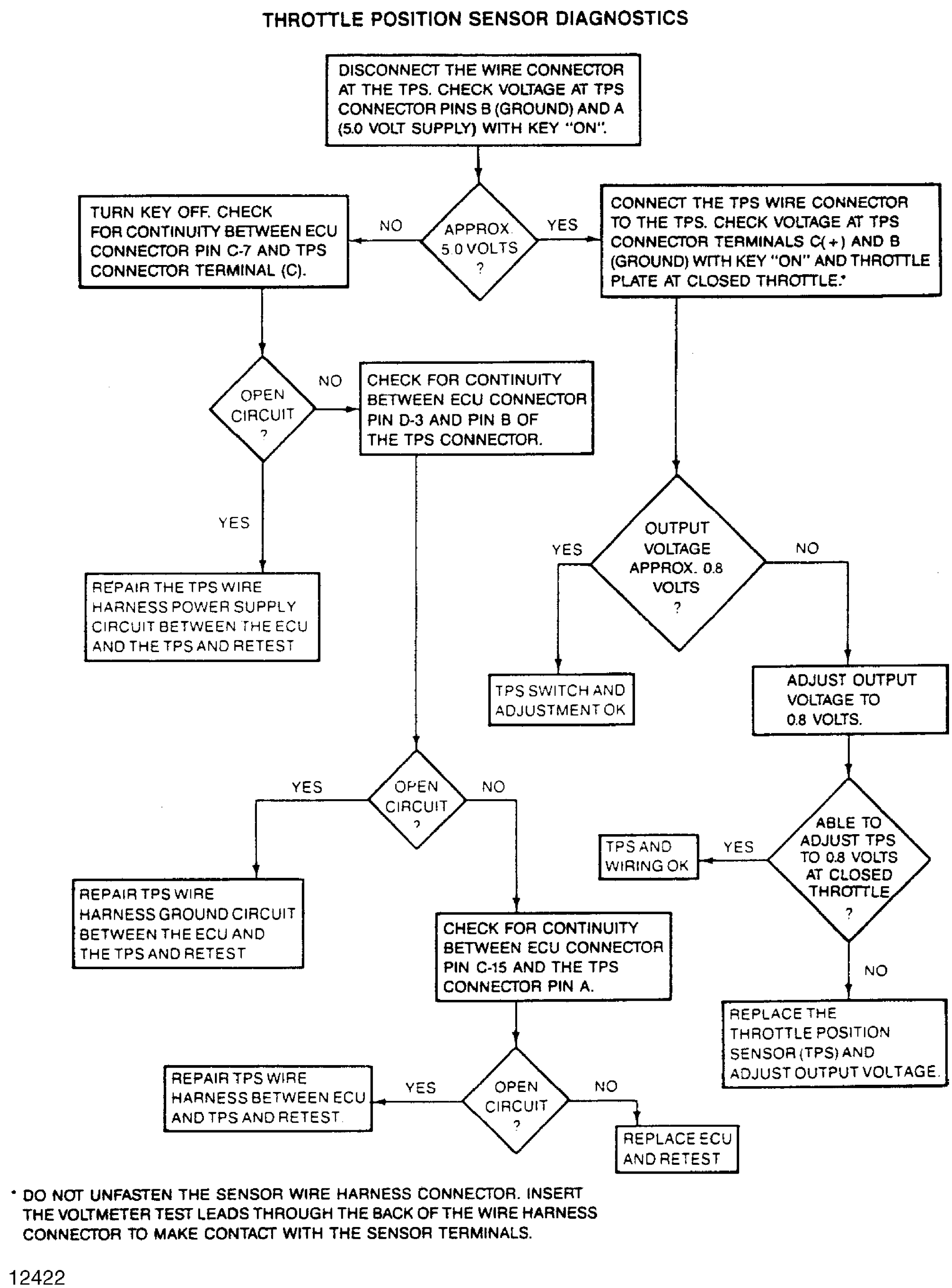


Fig. 8: Throttle Position Sensor Diagnostics

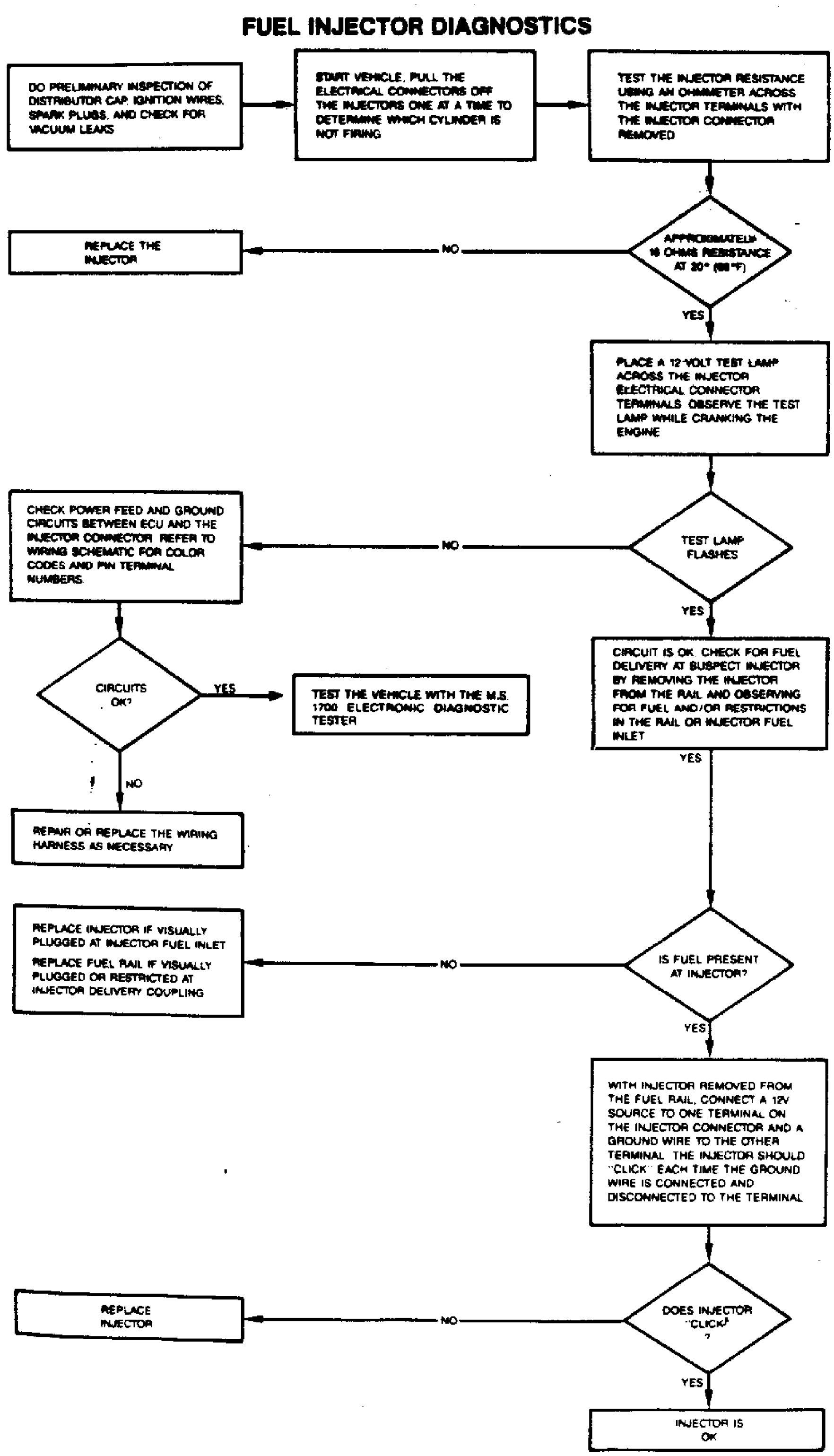
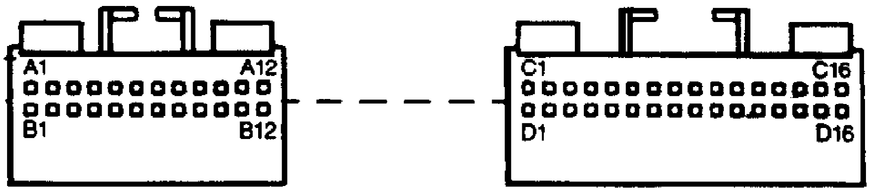


Fig. 9: Fuel Injector Diagnostics

ECU CONNECTORS



24-PIN CONNECTOR

32-PIN CONNECTOR

24-PIN CONNECTOR
TERMINAL IDENTIFICATION

A1. Injector No. 3
A2. Injector No. 6
A3. Injector No. 2
A4. Injector No. 4
A5. Fuel Pump Relay Ground
A6. Not Used
A7. Oxygen Sensor Heater Relay Ground
A8. Shift Lamp
A9. Latch Relay Ground
A10. EGR Solenoid
A11. Not Used
A12. A/C Relay Ground

B1. Injector No. 1
B2. Injector No. 5
B3. Idle Speed Stepper Motor A_1
B4. Idle Speed Stepper Motor A^1
B5. Idle Speed Stepper Motor C_1
B6. Idle Speed Stepper Motor C^1
B7. Positive Battery Voltage
B8. Ignition Switch
B9. Not Used
B10. Latched Positive Battery Voltage
B11. Ground
B12. Ground

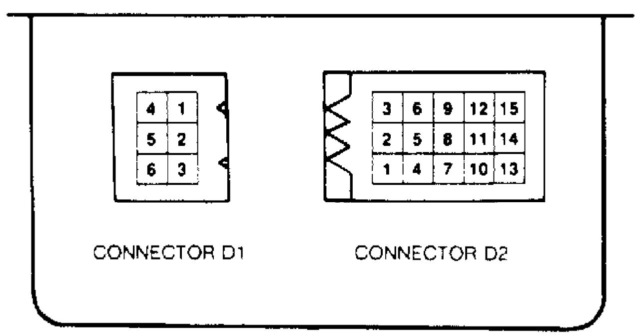
32-PIN CONNECTOR
TERMINAL IDENTIFICATION

C1. Speed Sensor Input
C2. A/C Request
C3. Start Signal
C4. Park/Neutral Switch
C5. "Sync" Input
C6. MAP Sensor Input
C7. TPS Input
C8. MAT Sensor Input
C9. Not Used
C10. CTS Input
C11. Injector Supply
C12. TX Serial Data
C13. Not Used
C14. MAP Sensor Output
C15. TPS Output
C16. "Sync" Output

D1. Speed Sensor Ground
D2. A/C Select
D3. Sensor Ground
D4. Not Used
D5. Not Used
D6. Not Used
D7. Not Used
D8. Knock Sensor Ground
D9. Oxygen Sensor Input
D10. Injector Feed
D11. RX Serial Data
D12. Not Used
D13. Spark/Dwell
D14. Not Used
D15. Not Used
D16. Knock Sensor Input

DIAGNOSTIC CONNECTORS

FRONT OF VEHICLE



CONNECTOR D1
TERMINAL IDENTIFICATION

1. Tach Input
2. Ignition
3. Ground
4. Start Solenoid
5. Battery
6. Fuel Pump

CONNECTOR D2
TERMINAL IDENTIFICATION

1. Shift Lamp
2. Power Latch Relay
3. Park/Neutral
4. Power Latched Relay (B+)
5. Air Conditioning Clutch Relay
6. Wide-Open Throttle Switch
7. Ground
8. Air Mixture Temperature
9. M.P.A. (Ignition Output)
10. EGR/Canister Purge Solenoid
11. Idle Speed Control Motor Forward
12. Coolant Temperature Sensor
13. Closed Throttle Switch
14. Idle Speed Control Motor Reverse
15. Not Used

Fig. 10: ECU Connector Pin & Diagnostic Connector Pin Identification

WIRING DIAGRAM

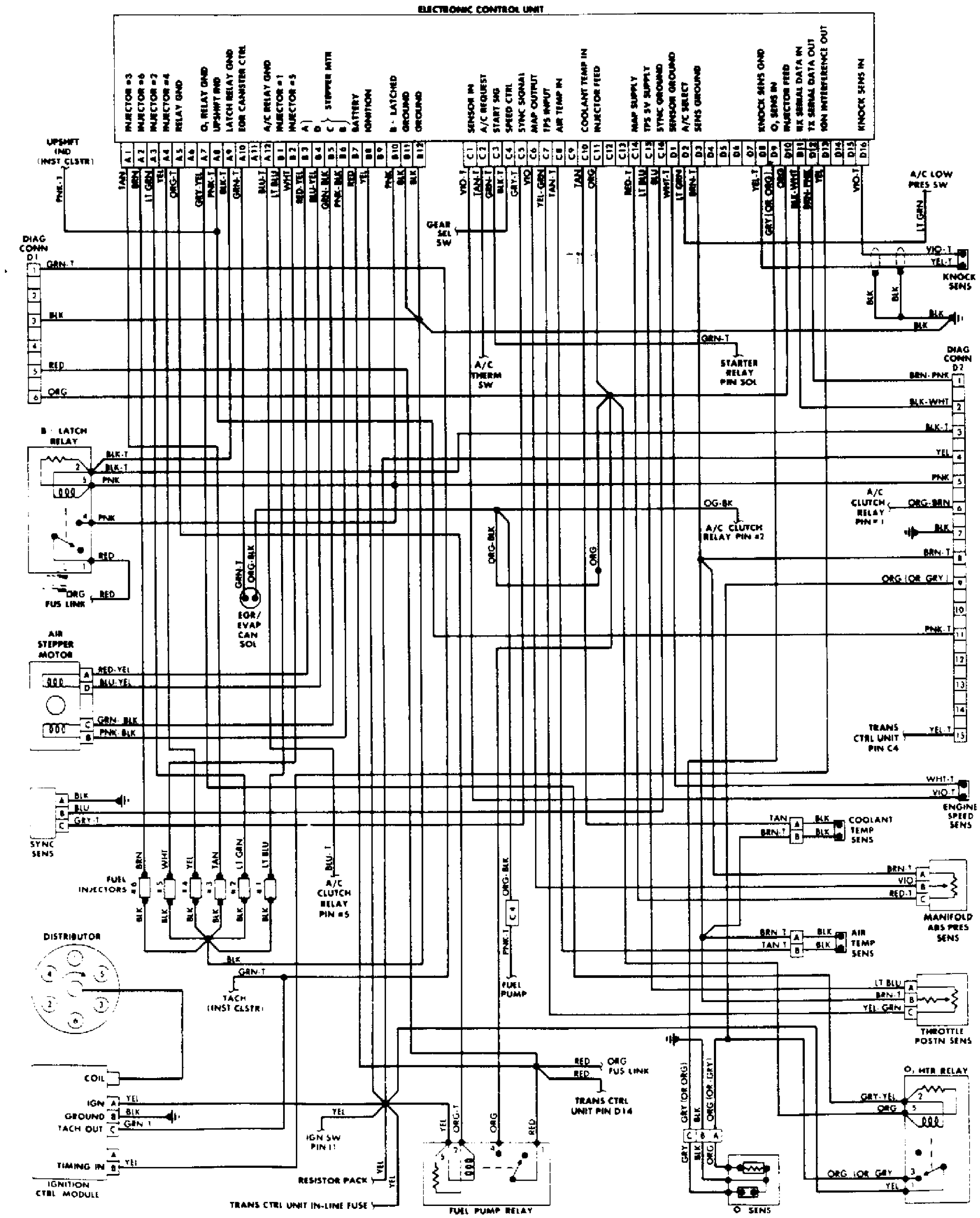
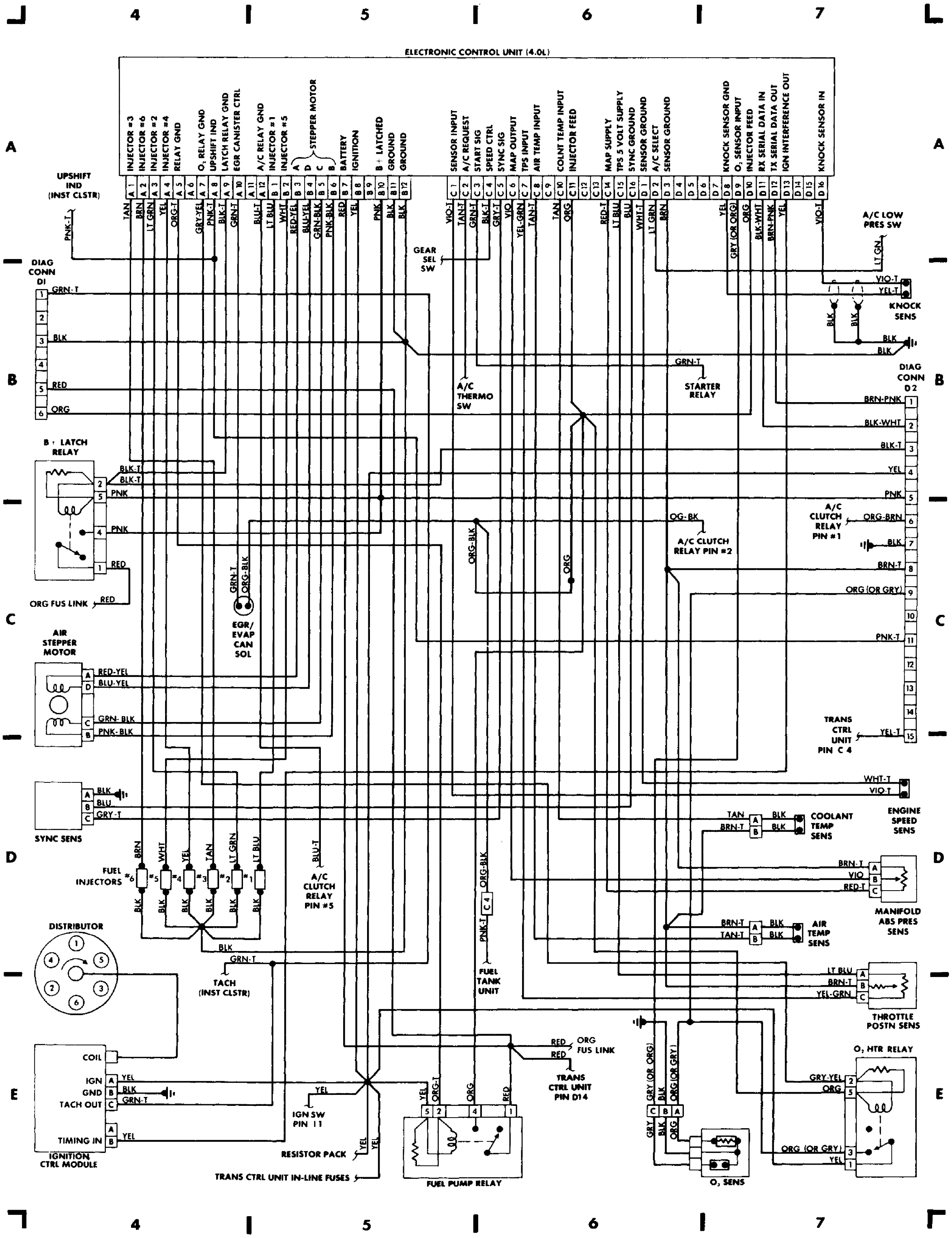


Fig. 11: Comanche Engine Control System Wiring Diagram



96608

Fig. 12: Cherokee Engine Control System Wiring Diagram

ABBREVIATIONS

1988 Jeep Cherokee

GENERAL INFORMATION

COMMONLY USED ABBREVIATION

"A" ABBREVIATION TABLE

"A" ABBREVIATION TABLE

ABBREVIATION	DEFINITION
A	Amperes
A/C	Air Conditioning
A/T	Automatic Transmission/Transaxle
AAP	Auxiliary Accelerator Pump
AB	Air Bleed
ABCV	Air Bleed Control Valve
ABDC	After Bottom Dead Center
ABRS	Air Bag Restraint System
ABS	Anti-Lock Brake System
AC	Alternating Current
ACC	A/C Clutch Compressor
ACCS	A/C Cycling Switch
ACCUM	Accumulator
ACCY	Accessory
ACT	Air Charge Temperature Sensor
ACV	Thermactor Air Control Valve
ADJ	Adjust or Adjustable
ADV	Advance
AFS	Airflow Sensor
AI	Air Injection
AIR or A.I.R.	Air Injection Reactor
AIS	Air Injection System
ALCL	Assembly Line Communications Link
ALDL	Assembly Line Diagnostic Link
ARC	Automatic Ride Control
ASCD	Automatic Speed Control Device
ASCS	Air Suction Control Solenoid
ASD	Auto Shutdown
ASDM	Air Bag System Diagnostic Module
ASV	Air Suction Valve
ATC	Automatic Temperature Control
ATDC	After Top Dead Center
ATF	Automatic Transmission Fluid
ATS	Air Temperature Sensor
AXOD	Automatic Transaxle Overdrive
Abs.	Absolute
Accy.	Accessory
Alt.	Alternator or Altitude
Amp.	Ampere
Assy.	Assembly
Auto.	Automatic
Aux.	Auxiliary
Avg.	Average

"B" ABBREVIATION TABLE

"B" ABBREVIATION TABLE

ABBREVIATION	DEFINITION
B/P	Backpressure
BAC	By-Pass Air Control
BAP	Barometric Absolute Pressure Sensor
BARO	Barometric
BBDC	Before Bottom Dead Center
BCM	Body Control Module
BDC	Bottom Dead Center
BHP	Brake Horsepower
BLK	Black
BLU	Blue
BMAP	Barometric & Manifold Absolute Pressure Sensor
BOO	Brake On-Off Switch
BP	Barometric Pressure sensor
BPS	Barometric Pressure Sensor
BPT	Backpressure Transducer
BRN	Brown
BTDC	Before Top Dead Center
BTU	British Thermal Unit
BVSV	Bimetallic Vacuum Switching Valve
Baro.	Barometric
Batt.	Battery
Bbl.	Barrel (Example: 4-Bbl.)
Blst.	Ballast
Blwr.	Blower
Brkr.	Breaker

"C" ABBREVIATION TABLE

"C" ABBREVIATION TABLE

ABBREVIATION	DEFINITION
° C	Celsius (Degrees)
C(3) I	Computer Controlled Coil Ignition
C(4)	Computer Controlled Catalytic Converter
CANP	Canister Purge solenoid
CARB	California Air Resources Board
CAT	Catalytic Converter
CB	Circuit Breaker
CBD	Closed Bowl Distributor
CBVV	Carburetor Bowl Vent Valve
cc	Cubic Centimeter
CCC	Computer Command Control
CCD	Computer Controlled Dwell
CCM	Central Control Module
CCO	Converter Clutch Override
CCOT	Cycling Clutch Orifice Tube
CCW	Counterclockwise
CDI	Capacitor Discharge Ignition
CEC	Computerized Engine Control
CFI	Central Fuel Injection
CID	Cubic Inch Displacement
CID	Cylinder Identification sensor
CIS	Continuous Injection System
CIS-E	Continuous Injection System-Electronic
CKT	Circuit
CLR	Clear
CNG	Compressed Natural Gas

CO	Carbon Monoxide
CO2	Carbon Dioxide
CONV	Convertible
CP	Canister Purge
CPA	Connector Position Assurance
CPS	Crank Position Sensor
CTS	Coolant Temperature Sensor
CV	Check Valve or Constant Velocity
CVC	Constant Vacuum Control
CW	Clockwise
CYL or Cyl.	Cylinder
Calif.	California
Carb.	Carburetor
Chrg.	Charging
Circ.	Circuit
Cntrl.	Control
Comp.	Compressor or Compartment
Conn.	Connector
Cont.	Continued
Conv.	Convertible or Converter
Cu. In.	Cubic Inch
Cyl.	Cylinder

"D" ABBREVIATION TABLE

"D" ABBREVIATION TABLE

ABBREVIATION	DEFINITION
"D"	Drive
DBC	Dual Bed Catalyst
DC	Direct Current or Discharge
DDD	Dual Diaphragm Distributor
DERM	Diagnostic Energy Reserve Module
DFI	Digital Fuel Injection
DIC	Driver Information Center
DIS	Direct Ignition System
DIS	Distributorless Ignition System
DIST	Distribution
DISTR	Distributor
DK BLU	Dark Blue
DK GRN	Dark Green
DME	Digital Motor Electronics (Motronic System)
DOHC	Double Overhead Cam
DOT	Department of Transportation
DP	Dashpot
DRB-II	Diagnostic Readout Box
DVOM	Digital Volt/Ohm Meter (see VOM)
Def.	Defogger or Defroster
Def.	Defrost
Defog.	Defogger
Diag.	Diagnostic
Dist.	Distributor or Distribution
Dr.	Door

"E" ABBREVIATION TABLE

"E" ABBREVIATION TABLE

ABBREVIATION	DEFINITION

EAC	Electric Assist Choke
EACV	Electric Air Control Valve
EBCM	Electronic Brake Control Module
ECA	Electronic Control Assembly
ECAT	Electronically Controlled Automatic Transaxle
ECM	Electronic Control Module
ECT	Engine Coolant Temperature Sensor
ECU	Electronic Control Unit or Engine Control Unit
EDF	Electric Drive Fan relay assembly
EDIS	Electronic Distributorless Ignition System
EEC	Electronic Engine Control
EECS	Evaporative Emission Control System
EEPROM	Electronically Erasable PROM
EFE	Early Fuel Evaporation
EFI	Electronic Fuel Injection
EGO	Exhaust Gas Oxygen sensor (see HEGO)
EGR	Exhaust Gas Recirculation system
EGRC	EGR Control solenoid or system
EGRV	EGR Vent solenoid or system
EMR	Emission Maintenance Reminder Module
ESA	Electronic Spark Advance
ESC	Electronic Spark Control
EST	Electronic Spark Timing
ETR	Emergency Tensioning Retractor
EVAP	Fuel Evaporative System
EVIC	Electronic Vehicle Information Center
EVO	Electronic Variable Orifice
EVP	EGR Valve Position Sensor
EVR	EGR Valve Regulator
EVRV	Electronic Vacuum Regulator Valve
Elect.	Electronic
Eng.	Engine
Evap.	Evaporative
Exc.	Except

"F" ABBREVIATION TABLE

"F" ABBREVIATION TABLE

ABBREVIATION	DEFINITION
° F	Fahrenheit (Degrees)
F/B	Fuse Block
FBC	Feedback Carburetor
FI	Fuel Injector or Fuel Injection
FICD	Fast Idle Control Device
FIPL	Fuel Injector Pump Lever
FP	Fuel Pump
FPM	Fuel Pump Monitor
FPR-VSV	Fuel Pressure Regulator Vacuum Switching Valve
FWD	Front Wheel Drive
Fed.	Federal
Ft. Lbs.	Foot Pounds

"G" ABBREVIATION TABLE

"G" ABBREVIATION TABLE

ABBREVIATION	DEFINITION

g	grams
GND or GRND	Ground
GRN	Green
GRY	Gray
Ga.	Gauge
Gals.	gallons
Gov.	Governor

"H" ABBREVIATION TABLE

"H" ABBREVIATION TABLE

ABBREVIATION	DEFINITION
H/D	Heavy Duty
HAC	High Altitude Compensation
HC	Hydrocarbons
HEDF	High Speed Electro Drive Fan relay or circuit
HEGO	Heated Exhaust Gas Oxygen Sensor
HEGOG	HEGO Ground circuit
HEI	High Energy Ignition
HLDT	Headlight
HO	High Output
HP	High Performance
HSC	High Swirl Combustion
HSO	High Specific Output
HTR	Heater
HVAC	Heating
Headlt.	Headlight
Hg	Mercury
Hgt.	Height
Htr.	Heater
Hz	Hertz (Cycles Per Second)

"I" ABBREVIATION TABLE

"I" ABBREVIATION TABLE

ABBREVIATION	DEFINITION
I.D.	Inside Diameter
IAC	Idle Air Control
IACV	Idle Air Control Valve
IC	Integrated Circuit
ID	Identification
IDM	Ignition Diagnostic Monitor
IGN	Ignition system or circuit
ILC	Idle Load Compensator
In. Hg	Inches of Mercury
INCH Lbs.	Inch Pounds
INFL REST	Inflatable Restraint
INJ	Injector or Injection
IP	Instrument Panel
IPC	Instrument Panel Cluster
ISA	Idle Speed Actuator
ISC	Idle Speed Control
ISS	Idle Stop Solenoid
ITS	Idle Tracking Switch
IVSV	Idle Vacuum Switching Valve

Ign.	Ignition
In.	Inches
Inj.	Injector

"J" ABBREVIATION TABLE

"J" ABBREVIATION TABLE

ABBREVIATION	DEFINITION
J/B	Junction Block

"K" ABBREVIATION TABLE

"K" ABBREVIATION TABLE

ABBREVIATION	DEFINITION
k/ohms	1000 ohms (kilo as in k/ohms)
kg	Kilograms (weight)
kg/cm^2	Kilograms Per Square Centimeter
KAM	Keep Alive Memory
KAPWR	Keep Alive Power
KM/H	Kilometers Per Hour
KOEO	Key On Engine Off
KOER	Key On Engine Running
KS	Knock Sensor

"L" ABBREVIATION TABLE

"L" ABBREVIATION TABLE

ABBREVIATION	DEFINITION
L	Liter(s)
L/D	Light Duty
LCD	Liquid Crystal Display
LED	Light Emitting Diode
LH	Left Hand
LOS	Limited Operation Strategy
LT BLU	Light Blue
LT GRN	Light Green
LUS	Lock-Up Solenoid
Lbs.	Pounds
Lt(s).	Light(s)
Lugg.	Luggage

"M" ABBREVIATION TABLE

"M" ABBREVIATION TABLE

ABBREVIATION	DEFINITION
mA	Milliamps
mV	Millivolts
mfd.	Microfarads

mm	Millimeters
M/T	Manual Transaxle or Transmission
MA PFI	Mass Air Sequential Port Fuel Injection system
MA or MAF	Mass Airflow
MAF	Mass Air Flow sensor
MAFS	Mass Airflow Sensor
MAP	Manifold Absolute Pressure sensor
MAT	Manifold Air Temperature
MCU	Microprocessor Control Unit
MCV	Mixture Control Valve
MEM-CAL	Memory Calibration Chip
MFI	Multiport Fuel Injection
MIL	Malfunction Indicator Light
MLP	Manual Lever Position
MPFI	Multi Point Fuel Injection
MPH	Miles Per Hour
MPI	Multi-Point (Fuel) Injection
Man.	Manual
Mech.	Mechanical
Mem.	Memory
Mtr.	Motor

"N" ABBREVIATION TABLE

"N" ABBREVIATION TABLE

ABBREVIATION	DEFINITION
N.m	Newton-Meter
NA	Not Available
NDS	Neutral Drive Switch
NGS	Neutral Gear Switch
NOx	Oxides of Nitrogen
NPS	Neutral Pressure Switch
No.	Number
Nos.	Numbers

"O" ABBREVIATION TABLE

"O" ABBREVIATION TABLE

ABBREVIATION	DEFINITION
O	Oxygen
O.D.	Outside Diameter
O/S	Oversize
O2	Oxygen
OC	Oxidation Catalyst
OCC	Output Circuit Check
OD	Overdrive
ODO	Odometer
OHC	Overhead Camshaft
ORG	Orange
OSC	Output State Check
Opt.	Option or Optional
oz.	Ounce
ozs.	Ounces

"P" ABBREVIATION TABLE

"P" ABBREVIATION TABLE

ABBREVIATION	DEFINITION
"P"	Park
P/C	Printed Circuit
P/N	Park/Neutral
P/S	Power Steering
PAV	Pulse Air Valve
PC-SOL	Purge Control Solenoid
PCM	Powertrain Control Module
PCS	Purge Control Solenoid
PCSDM	Passenger Compartment Sensor/Diagnostic Module
PCV	Positive Crankcase Ventilation
PFE	Pressure Feedback EGR sensor or circuit
PFI	Port Fuel Injection (see MA SEFI)
PGM-CARB	Programmed Carburetor
PGM-FI	Programmed Fuel Injection
PIP	Profile Ignition Pickup
PNK	Pink
PPL	Purple
PRNDL	Park Reverse Neutral Drive Low
PROM	Programmable Read-Only Memory
psi	Pounds Per Square Inch
PSPS	Power Steering Pressure Switch
PTC	Positive Temperature Coefficient
PTO	Power Take-Off
PWR GND	Power Ground circuit
Pkg.	Package
Press.	Pressure
Prog.	Programmed or Programmable
Pts.	Pints
Pwr.	Power

"Q" ABBREVIATION TABLE

"Q" ABBREVIATION TABLE

ABBREVIATION	DEFINITION
Qts.	Quarts

"R" ABBREVIATION TABLE

"R" ABBREVIATION TABLE

ABBREVIATION	DEFINITION
RABS	Rear Anti-Lock Brake System
RAC	Remote Accessory Control
RAM	Random Access Memory
RAP	Retained Accessory Power
RECIRC	Recirculation
RED	Red
RH	Right Hand
ROM	Read Only Memory
RPM	Revolutions Per Minute

RVB	Rear Vacuum Break
RWAL	Rear Wheel Anti-Lock Brake
RWD	Rear Wheel Drive
Recirc.	Recirculate or Recirculation
Reg.	Regulator
Rly.	Relay

"S" ABBREVIATION TABLE

"S" ABBREVIATION TABLE

ABBREVIATION	DEFINITION
SAW	Spark Angle Word
SBC	Single Bed Converter
SBEC	Single Board Engine Controller
SC	Super Charged
SCC	Spark Control Computer
SCS	Air Suction Control Solenoid
SDM	Supplemental Restraint System Diagnostic Module
SDU	SRS Diagnostic Unit
SEN	Sensor
SES	Service Engine Soon
SFI	Sequential (Port) Fuel Injection
SIG RTN	Signal Return circuit
SIL	Shift Indicator Light
SIR	Supplemental Inflatable Restraint
SMEC	Single Module Engine Controller
SOHC	Single Overhead Cam
SOL or Sol.	Solenoid
SPFI	Sequential Port Fuel Injection
SPK	Spark Control
SPOUT	Spark Output Signal
SRS	Supplemental Restraint System (Air Bag)
SS 3/4-4/3	Shift Solenoid circuit
SSI	Solid State Ignition
STAR	Self-Test Automatic Readout
STI	Self Test Input circuit
STO	Self-Test Output
SUB-O2	Sub Oxygen Sensor
Sen. or Sens.	Sensor
Sol.	Solenoid
Sprchg.	Supercharger
Strg.	Steering
Susp.	Suspension
Sw.	Switch
Sys.	System

"T" ABBREVIATION TABLE

"T" ABBREVIATION TABLE

ABBREVIATION	DEFINITION
T.V.	Throttle Valve
TAB	Thermactor Air By-Pass
TAC	Thermostatic Air Cleaner
TAD	Thermactor Air Diverter
TAN	Tan
TBI	Throttle Body Injection

TCC	Torque Converter Clutch
TCCS	Toyota Computer Control System
TDC	Top Dead Center
TDCL	Total Diagnostic Communication Link
TFI	Thick Film Ignition system
TGS	Top Gear Switch (cancels SIL in top gear)
THERMAC	Thermostatic Air Cleaner
THS	Transmission Hydraulic Switch
TP/TPS	Throttle Position Sensor
TPI	Tuned Port Injection
TPS	Throttle Position Sensor/Switch
TS	Temperature Sensor
TSB	Technical Service Bulletin
TTS	Transmission Temperature Switch
TV	Thermovalve
TWC	Three-Way Catalyst
Temp.	Temperature
Trans.	Transaxle/Transmission

"V" ABBREVIATION TABLE

"V" ABBREVIATION TABLE

ABBREVIATION	DEFINITION
V	Valve
VAF	Vane Air Flow sensor or circuit
VAPS	Variable Assist Power Steering
VAT	Vane Air Temperature
VATS	Vehicle Anti-Theft System
VBATT	Vehicle Battery Voltage
VCC	Viscous Converter Clutch
VIN	Vehicle Identification Number
VIO	Violet
VLR	Volt Loop Reserve
VM	Vacuum Modulator
VM	Vane Meter
VOM	Volt-Ohmmeter (Analog)
VPWR	Vehicle Power supply voltage (10-14 volts)
VREF	Voltage Reference (ECA supplied reference voltage
VRV	Vacuum Regulator Valve
VSC	Vehicle Speed Control sensor or signal
VSS	Vehicle Speed Sensor or signal
VSV	Vacuum Switching Valve
Vac.	Vacuum
Volt.	Voltage

"W" ABBREVIATION TABLE

"W" ABBREVIATION TABLE

ABBREVIATION	DEFINITION
W/	With
W/O	Without
WAC	WOT A/C Cut-off switch or circuit
WAC	Wide Open Throttle A/C Switch
WHT	White
WOT	Wide Open Throttle
YEL	Yellow

A/C COMPRESSOR OIL CHECKING

1988 Jeep Cherokee

A/C General Servicing
COMPRESSOR OIL CHECK

* PLEASE READ THIS FIRST *

CAUTION: When discharging air conditioning system, use only approved refrigerant recovery/recycling equipment. Make every attempt to avoid discharging refrigerant into the atmosphere.

ISOLATING COMPRESSOR - GRAND WAGONEER ONLY

1) Connect service gauge set to the compressor service valves and open compressor valves slightly (turn clockwise). Start engine and operate air conditioning. Slowly turn compressor suction valve clockwise toward closed (front-seated) position.

2) When suction pressure is reduced to zero or less, turn off engine and compressor and quickly turn suction valve stem in to full front-seated position. Suction pressure should be slightly above zero. Turn discharge valve into front-seated position.

3) To check oil lever, slowly open crankcase plug to relieve any remaining pressure. After oil level is correct, cap service gauge parts on both valves. Back-seat suction service valve to allow refrigerant to enter compressor. Open discharge valve halfway.

4) Loosen discharge service valve cap, allowing refrigerant pressure to force air out of compressor. Back-seat service valve and tighten cap. Compressor is now ready for operation.

REFRIGERANT OIL

Only new, pure, moisture-free refrigerant oil should be used in the air conditioning system. This oil is highly refined and dehydrated to a point where moisture content is less than 10 parts per million. The oil container must be tightly closed at all times when not in use, or moisture will be absorbed from the air and introduced into the refrigeration system.

DISCHARGING SYSTEM

CAUTION: When discharging air conditioning system, use only approved refrigerant recovery/recycling equipment. Make every attempt to avoid discharging refrigerant into the atmosphere.

If compressor has stem-type service valves, it can be isolated and removed without discharging entire system. Otherwise, discharge system completely using approved refrigerant recovery/recycling equipment before loosening any fittings.

DISCONNECTING LINES & FITTINGS

After system is discharged, carefully clean area around all fittings to be opened. Always use 2 wrenches when tightening or loosening fittings to avoid twisting or distorting lines. Cap or plug all openings as soon as lines are removed. Do not remove caps until immediately before connections are made. This will keep entry of air and moisture to a minimum, reducing the chance of damage to components.

PLACING SYSTEM IN OPERATION

After component service or replacement has been completed and all connections have been made, evacuate system throughly with a vacuum pump. Charge system with proper amount of refrigerant and perform a leak test. Be sure to check all fittings that have been opened. After system has been leak tested, make a system performance check.

SANDEN SD508 5-CYLINDER OIL CHECKING

1) Discharge system using approved refrigerant recovery/recycling equipment. Remove compressor belt and loosen mounting bolts. Rotate compressor in brackets until filler plug is at top. Clean area around filler plug and remove plug slowly. Rotate front hub plate so notch in lobe is 110 degrees from the bottom. This rotates ball end of top piston to align with oil fill port and allows clearance for dipstick. See Fig. 1.

2) Insert compressor dipstick diagonally from right to left until stop on dipstick contacts filler plug surface. Remove dipstick and note oil fill level. Each mark on dipstick represents one ounce of oil. Add oil if necessary to reach 3-4 ounce level.

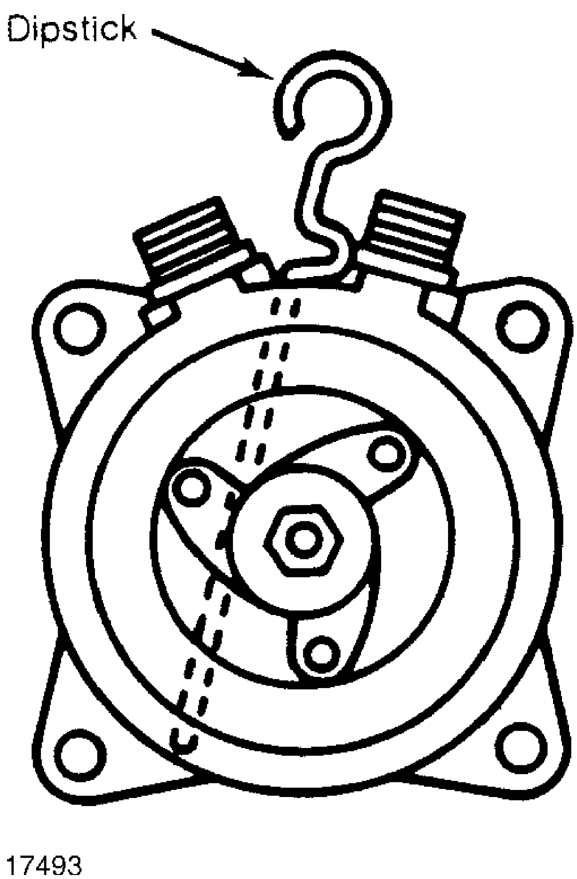


Fig. 1: Sanden 5-Cylinder Oil Level Checking

YORK - 2-CYLINDER - PURGINE COMPRESSOR

1) Remove gauge set and place caps on service valve ports. Back-seat the suction service valve to allow refrigerant to enter compressor.

2) Loosen discharge port valve slightly. Loosen valve port cap to allow refrigerant to force out air from compressor. Back-seat the discharge valve and tighten the port cap. Compressor is ready for service.

YORK - 2-CYLINDER COMPRESSOR OIL CHECKING

1) Operate system for 10 minutes, then stop and isolate compressor. Loosen filler plug slowly to release any pressure in crankcase.

2) Use dipstick to check oil level. See Fig. 2. Add oil as necessary, then install plug with new "O" ring. Purge compressor of air.

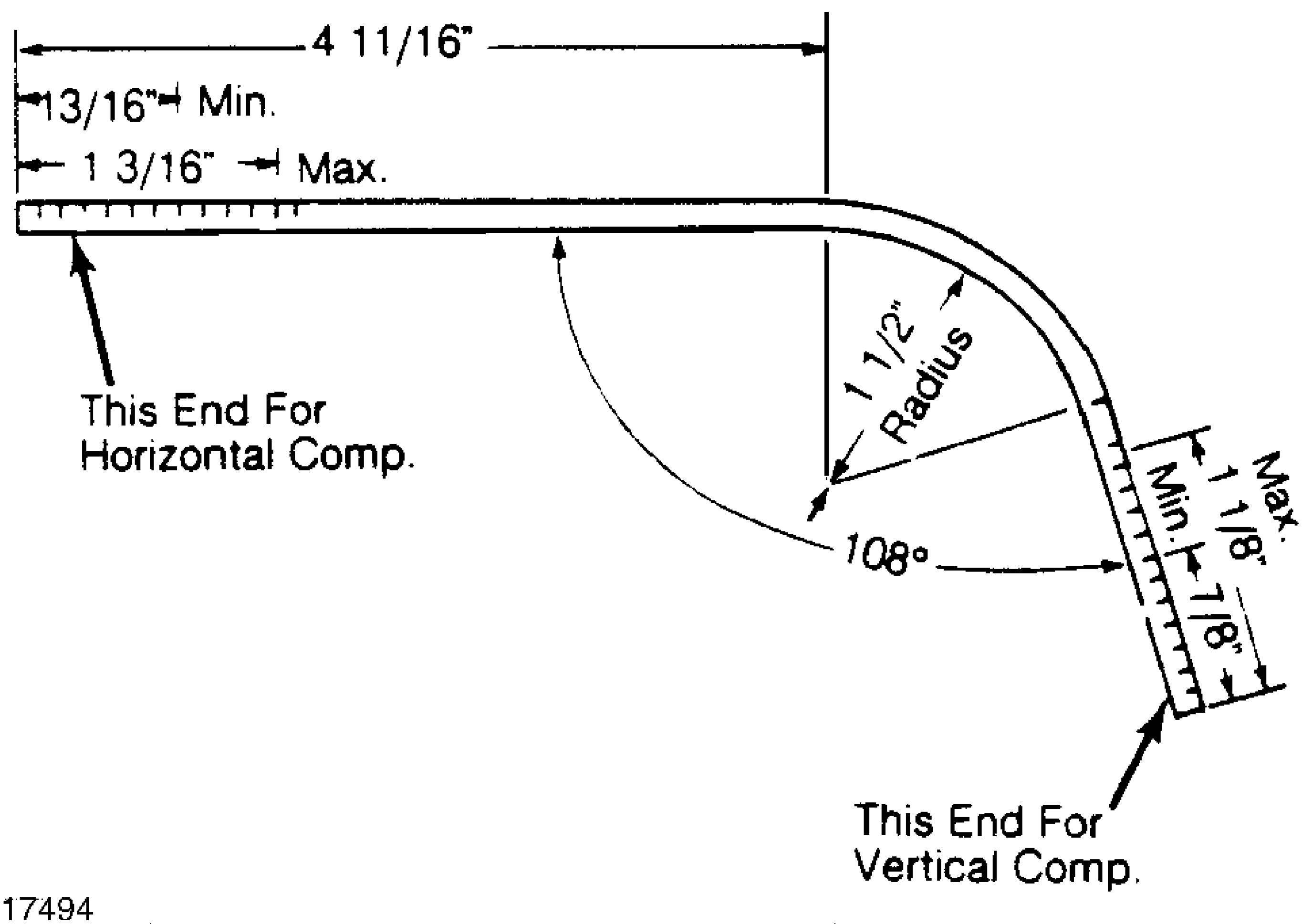


Fig. 2: York A/C Compressor Oil Level Dipstick (Check oil w/ shaft keyway facing head)
Courtesy of Chrysler Motors.

A/C-HEATER SYSTEM - MANUAL

1988 Jeep Cherokee

1988 Manual A/C-Heater Systems
JEEP

* PLEASE READ THIS FIRST *

CAUTION: When discharging air conditioning system, use only approved refrigerant recovery/recycling equipment. Make every attempt to avoid discharging refrigerant into the atmosphere.

DESCRIPTION

On Cherokee, Comanche and Wagoneer, the Climate Control System is an integral assembly combining air conditioning, heating and ventilating capabilities for models with air conditioning. The A/C registers are built into instrument panel.

On Wrangler models, a dual flow unit with the capability of recirculating air or drawing air from outside is used. It incorporates under-dash registers and uses a blend-air type system.

The A/C components include a compressor, condenser, receiver-drier, a sight glass (in the receiver-to-evaporator line) and evaporator housing. Evaporator housing contains evaporator core, expansion valve, thermostat, wiring and drain tube. Blower motor and fan are located in blower housing, which is attached to evaporator housing.

Vents provided in evaporator housing are adjustable to direct air to different positions in vehicle's interior. System controls include fan and temperature control knobs built into lower evaporator housing assembly or temperature and mode levers on control panel integrated with instrument panel.

OPERATION

A/C SYSTEM CONTROLS

Temperature & Fan Control Knobs
(Wrangler)

The right rotary control knob allows selection of desired temperature. Knob has "OFF" "1", "2" and "3" positions for different levels of cooling. The left rotary fan switch (knob) controls blower motor speed. Knob has "OFF", "LOW", "MED" and "HI" positions. Fan will operate unless mode control lever is in "OFF" position.

The A/C fan switch is a 3-speed unit used in conjunction with a blower motor resistor. Fan switch controls low, medium and high speed operation. Switch may be serviced by removing access plate located on lower evaporator core housing, below control panel.

The A/C temperature control switch has a thermostat unit built-in. Cooling adjustment is done by turning knob in a clockwise rotation. For fast, efficient system operation in hot weather, vehicle should be purged of hot air by driving about 2-3 city blocks with at least one window open. During this time, temperature control knob should be rotated clockwise to "MAX" position and fan control knob placed in "HI" position. This allows evaporator to pre-cool and avoid typical first blast of warm air.

Temperature Control Panel
(Cherokee, Comanche & Wagoneer)

The upper temperature control (mode) lever includes "MAX", "NORM", "BI-LEVEL", "VENT", "HEAT" and "OFF" positions. At the far end

of the scale, a symbol for defroster indicates defrost position. In "BI-LEVEL" position, a mixture of floor heat and defroster air is obtained.

The lower temperature control lever operates blend-air door in heater core housing. At full right position, all air is directed through heater core, providing maximum heat flow. At full left position, all air is directed around heater core providing fresh air. Control can be set in any intermediate position to provide a blend of heated and unheated air. Heater must be in heat or defrost mode before any air can enter vehicle.

TROUBLE SHOOTING

See JEEP TROUBLE SHOOTING at the end of this article.

REMOVAL & INSTALLATION

CONDENSER

Removal (Cherokee, Comanche & Wagoneer) NOTE: On these models, condenser and receiver-drier are replaced as a unit.

1) Drain radiator. Disconnect fan shroud and radiator hoses. Disconnect automatic transmission cooler lines (if equipped). Discharge A/C system using approved refrigerant recovery/recycling equipment.

2) Disconnect A/C hoses from condenser. Unplug low pressure switch. Remove radiator and condenser as an assembly. Detach condenser retaining bolts. Separate condenser from radiator. Remove receiver-drier from condenser.

NOTE: Plug receiver-drier openings whenever unit is removed from condenser. Add 1 oz. of refrigerant oil (AMC No. 8132400) to system when replacing condenser.

Installation

To install, reverse removal procedure. Fill radiator. Evacuate, leak test, recharge and check A/C system operation.

Removal (Wrangler)

1) Discharge system (slowly to prevent loss of compressor oil) using approved refrigerant recovery/recycling equipment. Drain coolant. Remove fan shroud and radiator. Disconnect pressure line at condenser. Remove condenser mounting screws. Tilt bottom of condenser toward engine.

2) From underside of vehicle, disconnect hose attaching receiver-drier to evaporator. Plug all openings to prevent entry of dirt or moisture. Remove receiver-drier and condenser assembly. Remove receiver-drier from condenser.

Installation

To install, reverse removal procedure. Fill radiator. Evacuate, leak test, recharge and check A/C system operation.

RECEIVER-DRIER

NOTE: On Cherokee, Comanche and Wagoneer, receiver-drier is removed with condenser and radiator as an assembly.

Removal (Wrangler)

Discharge system (slowly to prevent loss of compressor oil) using approved refrigerant recovery/recycling equipment. Disconnect evaporator and condenser lines from receiver-drier. Detach mounting screws from receiver-drier bracket. Remove receiver-drier.

Installation

To install, reverse removal procedure. Evacuate, leak test, recharge. Check A/C system for proper operation.

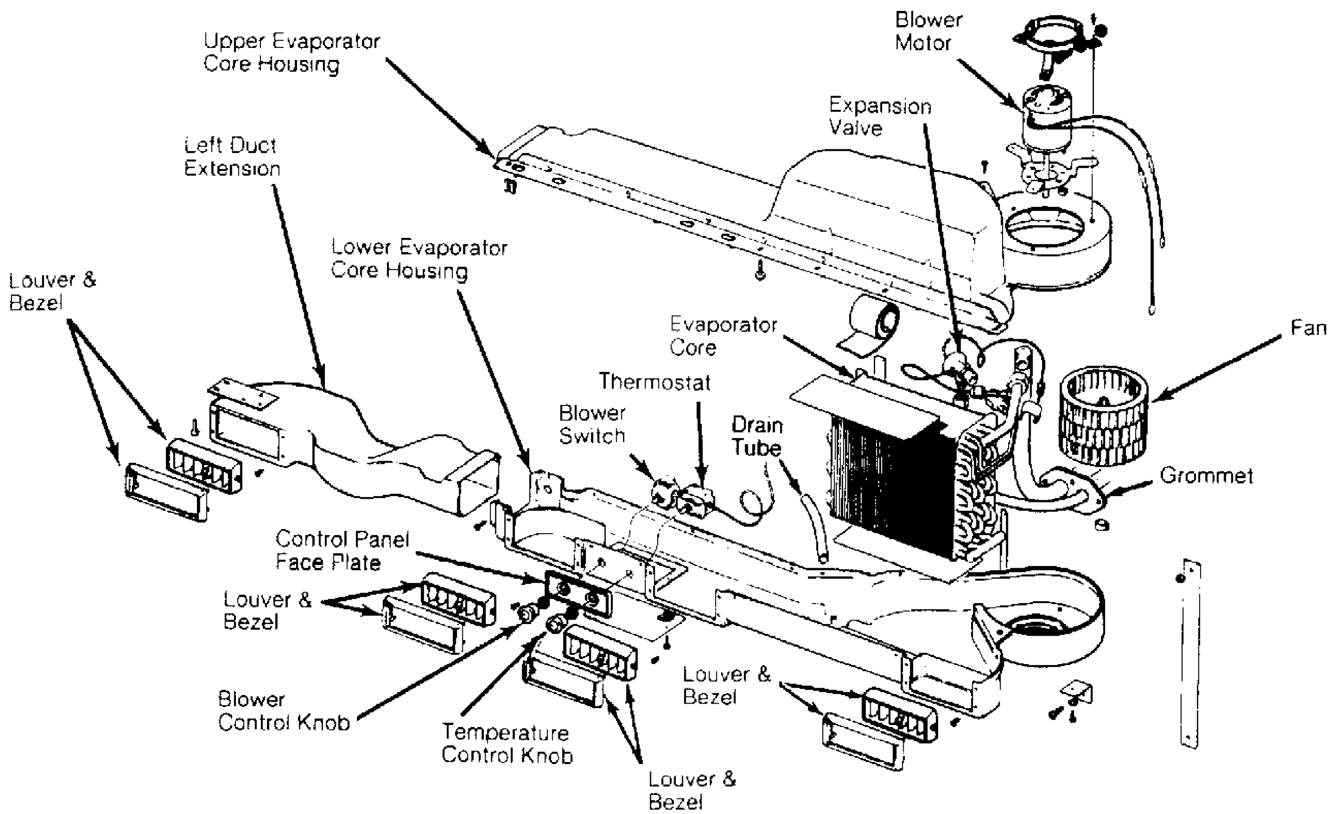


Fig. 1: Exploded View of Wrangler Evaporator Housing
Courtesy of Chrysler Motors.

EVAPORATOR-BLOWER HOUSING &

HEATER & EVAPORATOR CORES

NOTE: The following procedures are for vehicles with A/C-heater systems only. For replacement of heater cores on vehicles with heater systems only, see HEATER SYSTEMS, JEEP article.

Removal (Cherokee, Comanche & Wagoneer)

1) Disconnect battery ground. Discharge A/C system using approved refrigerant recovery/recycling equipment. Disconnect A/C hoses from expansion valve. Drain cooling system. Disconnect heater hoses at core tubes. Disconnect blower motor wires and vent tube.

2) Remove console (if equipped). Remove lower instrument panel. Disconnect electrical connectors at A/C relay, blower motor resistors and A/C thermostat. Disconnect vacuum hose at vacuum motor. Cut plastic retaining strap holding evaporator-blower housing to heater core housing.

3) Disconnect blend-air heater control cable. Detach clip at rear of blower housing flange and remove retaining screws. Remove

housing attaching nuts from studs on engine compartment side of dash panel. Remove evaporator drain tube.

4) Remove right kick panel. Detach instrument panel support bolt. Gently pull on right side of dash, then rotate housing downward and toward rear of vehicle to disengage housing studs from dash panel. Remove evaporator-blower housing.

5) To remove heater core, detach retaining screws. Remove heater core by pulling straight out of housing. To remove evaporator core, detach top housing retaining screws, then remove top of evaporator housing.

6) Remove thermostatic switch and capillary tube. Detach 2 evaporator retaining screws and lift evaporator core from housing. Remove expansion valve from evaporator.

Installation

1) To install components, reverse removal procedure. When installing evaporator core, install thermostatic switch and capillary tube before installing top of housing.

2) When installing heater core, ensure seal is properly cemented in place to prevent it from moving when blower assembly is installed. Evacuate, leak test, recharge and check A/C system operation.

NOTE: The evaporator housing mounting location is similar to Wrangler, except blower motor is mounted horizontally to firewall.

Removal (Wrangler)

1) Discharge system using approved refrigerant recovery/recycling equipment. Disconnect inlet line at compressor. Disconnect hose, at quick-disconnect coupling, between receiver-drier and evaporator. Remove hose clamps and dash grommet retaining screws. See Fig. 2.

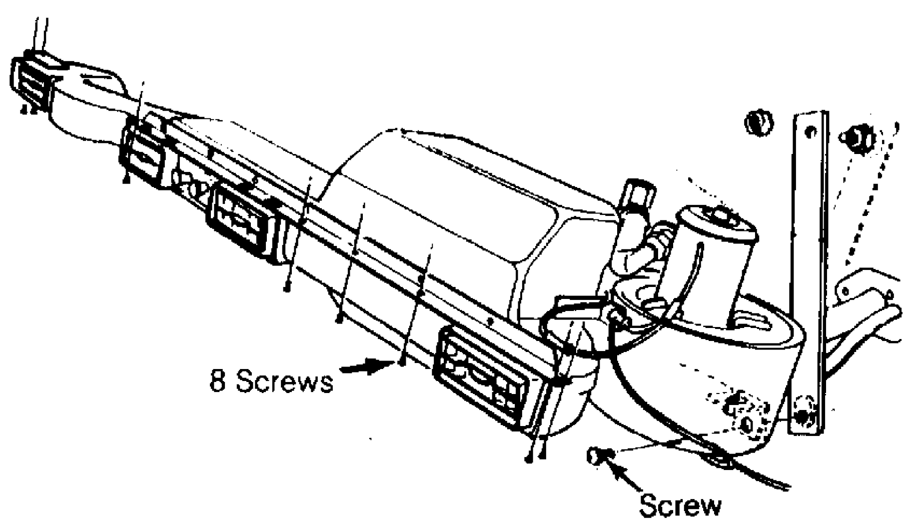


Fig. 2: Wrangler Evaporator Housing Mounting Screw Locations
Courtesy of Chrysler Motors.

NOTE: It is not necessary to discharge system to service blower motor. Evaporator housing may be lowered from instrument

panel to gain access to blower motor mounting screws.

2) Remove screws attaching evaporator housing to instrument panel and mounting bracket. Lower evaporator housing and pull hoses and grommet through opening.

Installation

To install, reverse removal procedure. Evacuate, leak test, recharge and check A/C system for proper operation.

EXPANSION VALVE

Removal (Cherokee, Comanche & Wagoneer)

Discharge A/C system using approved refrigerant recovery/recycling equipment. Disconnect A/C hoses from expansion valve. Disconnect expansion valve from evaporator core inlet and outlet tubes. Remove expansion valve.

Installation

To install, reverse removal procedure. Evacuate, leak test, recharge and check A/C system operation.

NOTE: The expansion valve is pre-set and should not be adjusted. A faulty valve requires replacement.

Removal (Wrangler)

1) Discharge system using approved refrigerant recovery/recycling equipment. Remove evaporator housing. Remove insulation wrapped around suction line and expansion valve.

2) Mark capillary tube location on suction line. Disconnect inlet and outlet connections, capillary tube clamp and equalizer tube. Remove expansion valve.

Installation

1) Clean suction line to provide positive contact with replacement expansion valve capillary tube. Connect inlet and outlet hoses. Clamp capillary tube securely at marked position and connect equalizer tube.

2) Wrap expansion valve and line with insulation. Install evaporator housing assembly. Evacuate, leak test, recharge and check A/C system operation.

TEMPERATURE CONTROL THERMOSTAT

Removal (Cherokee, Comanche & Wagoneer)

1) Disconnect battery ground. Remove console (if equipped). Remove lower instrument panel. Disconnect electrical connection at thermostat. See Fig. 3.

2) Remove capillary tube retaining screw. Remove thermostat retaining screws. Remove capillary tube from tube guide hole.

Installation

1) To install, feed capillary tube through tube guide hole until Red tape on capillary tube just enters hole in housing. Install capillary tube retaining screw and clip.

2) Install thermostat retaining screws and attach electrical connection. To complete installation, reverse removal procedure.

CAUTION: Handle capillary tube with care to avoid bends or kinks which could cause thermostat to malfunction.

Removal (Wrangler)

Remove evaporator housing assembly. Remove lower cover.

Carefully remove thermostat and capillary tube.

NOTE: On Wrangler models, servicing temperature control thermostat requires disassembly of evaporator core housing.

Installation

To install, insert capillary tube into evaporator coil a minimum of 2" (51 mm). See Fig. 4. Install thermostat and evaporator housing lower cover.

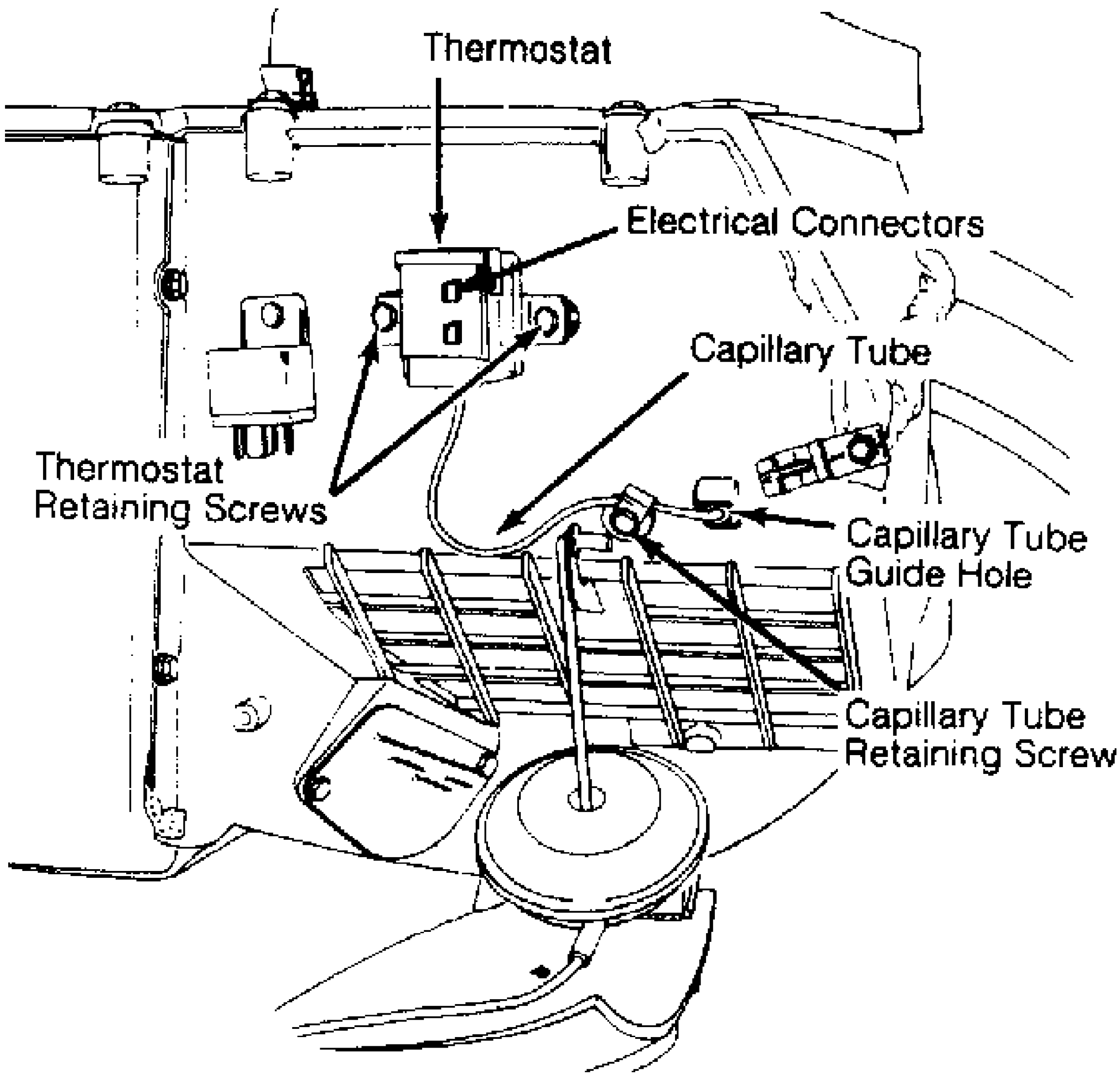


Fig. 3: Capillary Tube & Temperature Control Thermostat Locations
Cherokee, Comanche and Wagoneer locations are shown.

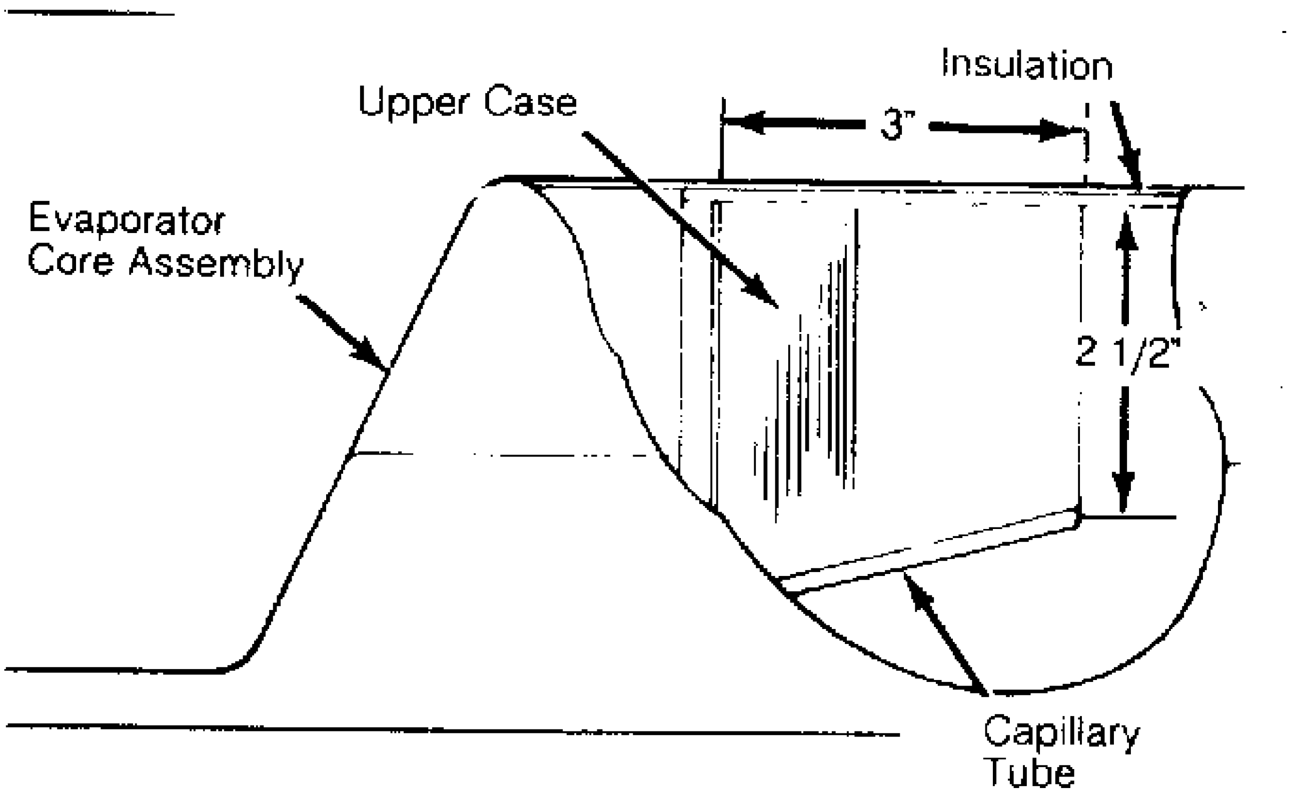


Fig. 4: Wrangler Capillary Tube Position
Courtesy of Chrysler Motors.

TROUBLE SHOOTING

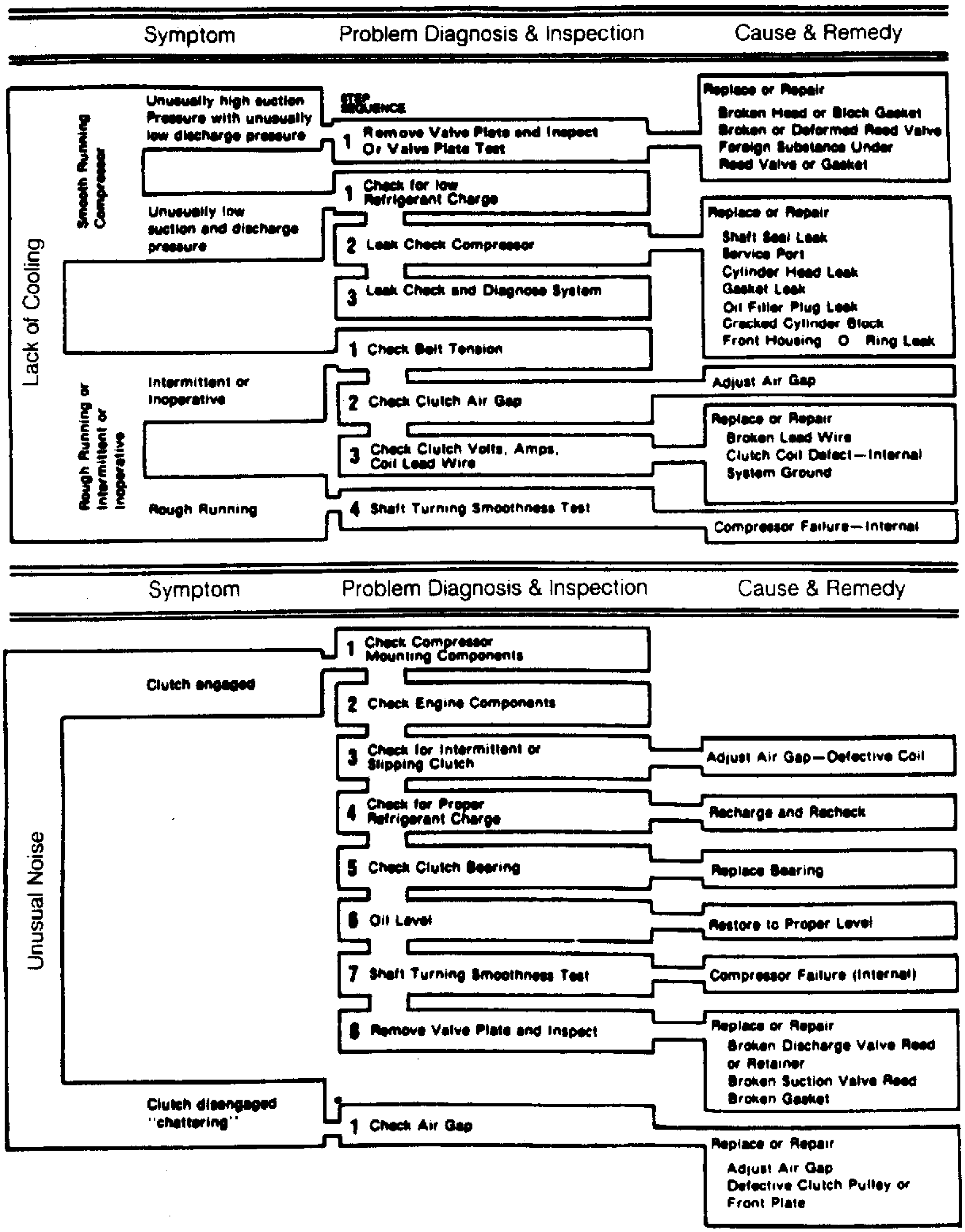


Fig. 5: Jeep Trouble Shooting Chart

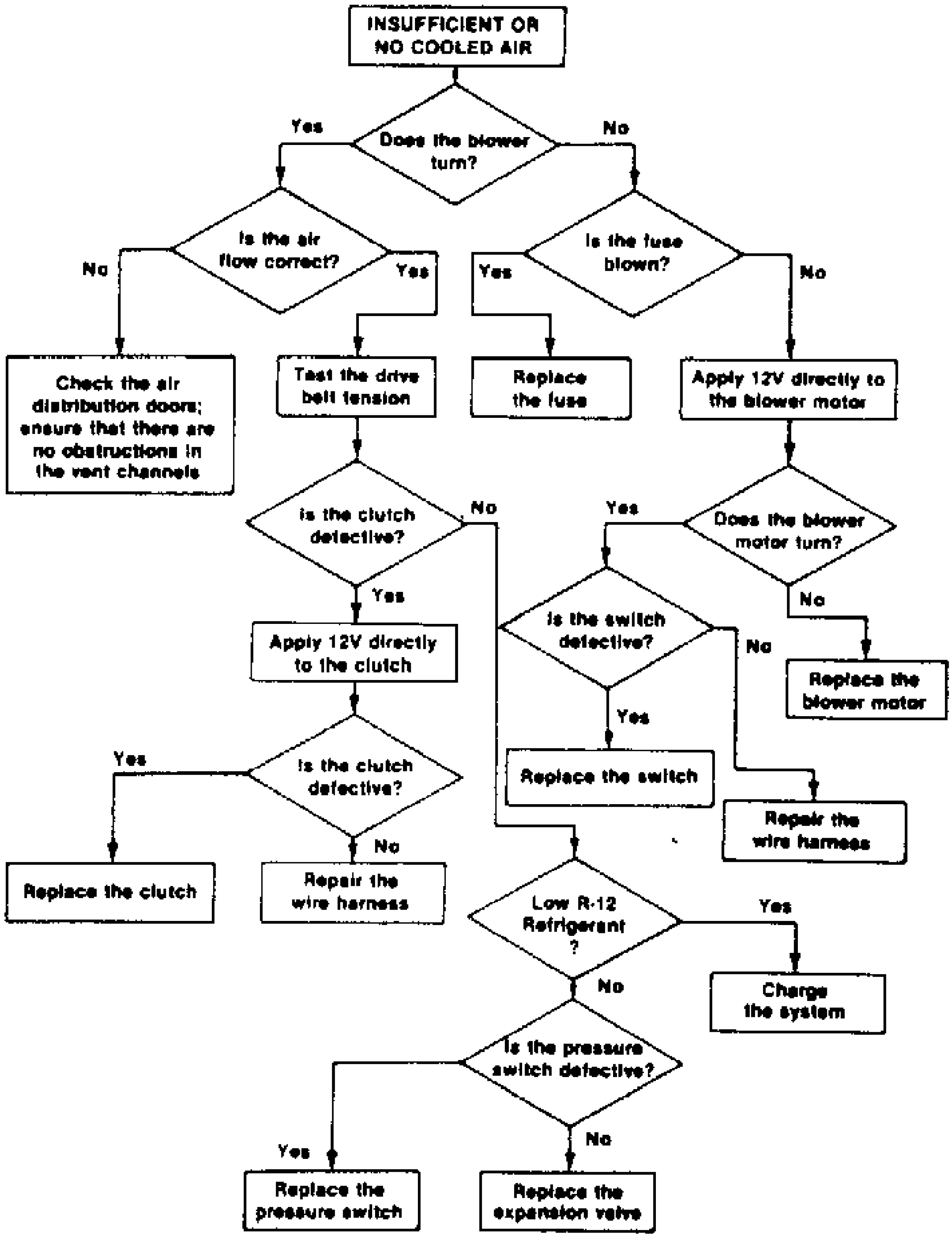
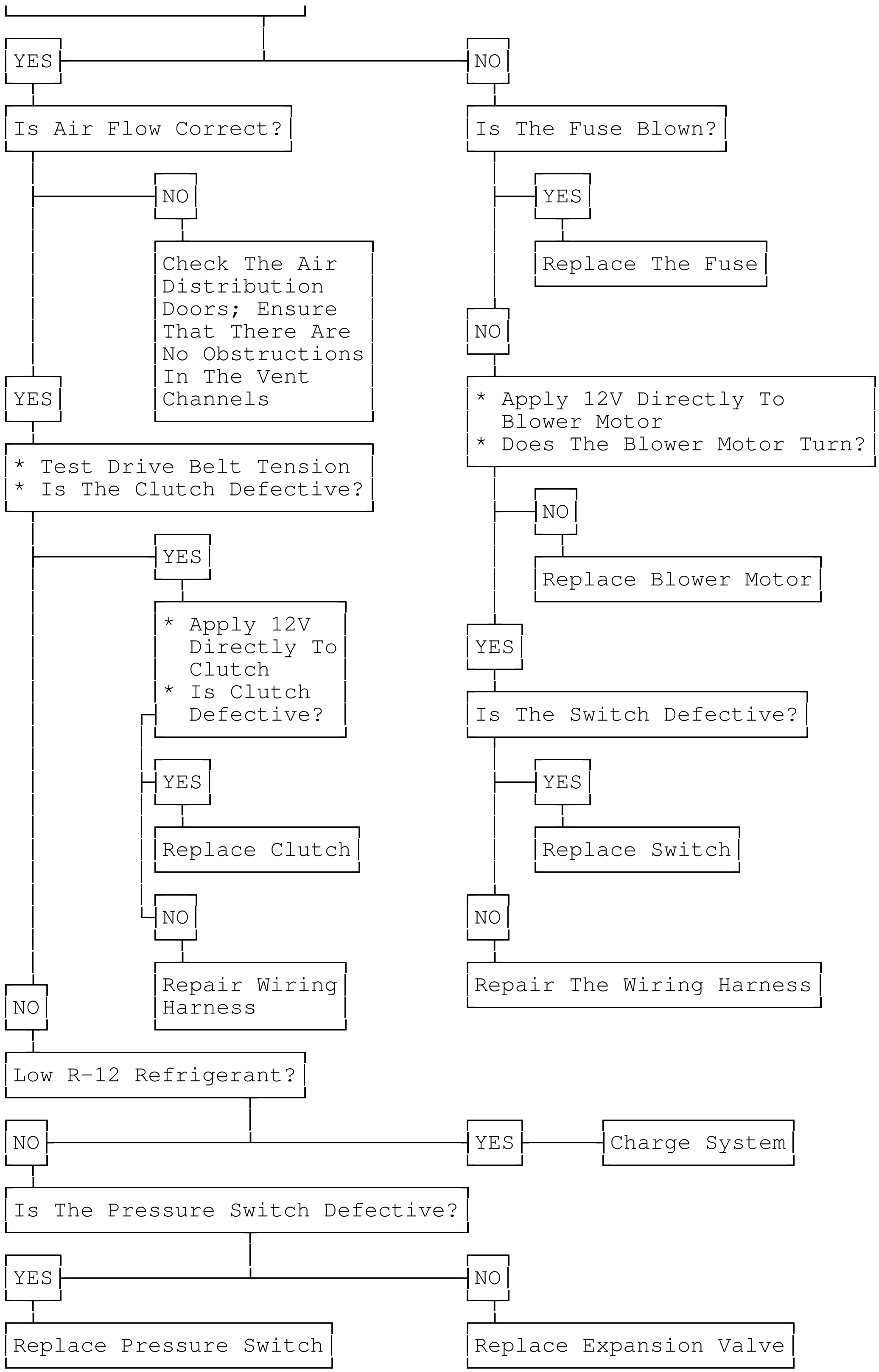


Fig. 6: Jeep Trouble Shooting Flow Chart

Does The Blower Turn?



CONDITION & POSSIBLE CAUSE

Compressor Runs Rough
* Incorrect oil or refrigerant level.
* Internal compressor damage.

Compressor Intermittent or Inoperative
* Drive belt slipping.
* Faulty clutch air gap.
* Clutch coil wiring broken or frayed.

Noisy Compressor
* Mounting bolts loose.
* Clutch slipping.
* Improper charge in system.
* Bad clutch or pulley bearings.
* Incorrect oil level.
* Valve plate damaged.
* Piston slap.

Excessive Vibration
* Incorrect belt tension.
* Clutch loose.
* Pulley misaligned.
* System overcharged.

A/C Air Flow Stops on Acceleration
* Defective vacuum storage tank.
* Vacuum line separated or defective.
* Vacuum switch defective.
* Vacuum leak.

High Suction Pressure with Very Low Discharge Pressure
* Valve plate or gasket broken or deformed.

Very Low Suction and Discharge Pressure
* Low refrigerant charge.
* Compressor leak.
* System leak.

Heater Control Valve Does Not Close with Vacuum Applied
* Faulty heater control valve.

No Vacuum at Heater Control Valve with Lever at Extreme Left
* Vacuum source hose disconnected.
* Leaking vacuum hose.
* Faulty check valve.
* Control panel switch defective or misadjusted.

Frozen Evaporator Core
* Faulty thermostat.
* Thermostat capillary tube improperly installed.
* Thermostat not adjusted properly.

Condensation Dripping in Passenger Compartment
* Drain hose plugged or improperly installed.
* Insulation missing or improperly installed.

TESTING

Note: The following test applies to all Jeep models except Cherokee and Wagoneer.

System Charge Test

1) To check system refrigerant level, a sight glass has been incorporated into the receiver-to-evaporator hose at the receiver end. A continuous stream of bubbles will appear in the sight glass of a system that is not properly charged. However, both properly charged systems and discharged systems will appear the same because of a lack of bubbles.

2) To test for discharge condition, cycle the clutch off and on with engine at 1500 RPM. When clutch is off, bubbles will appear if there is refrigerant in the system. If no bubbles appear, system is discharged. If discharged, leak test, repair and recharge system.

A/C SYSTEM OPERATION CHART & VACUUM DIAGRAM

A/C SYSTEM OPERATION TABLE

MODE LEVER POSITION	AIR DISCHARGE	BLOWER SPEEDS	PANEL DOOR	FLOOR DOOR	DEFROST DOOR	WATER VALVE
Off(1)(2)	Closed	None	Open	(3)	Closed	Closed
Max A/C (1)(4)	Panel Regis- ters With Floor Bleed	4	Open	Bleed	Closed	Open(5)
Norm A/C (7)(4)	Panel Regis- ters With Floor Bleed	4(6)	Open	Bleed	Closed	Open(5)
Bi-Level (7)(4)	Panel Registers and Floor With Def. Bleed	4(6)	Open	Open	Bleed	Open(1)
Vent (7)(2)	Panel Registers With Floor Bleed	4	Open	Bleed	Closed	Closed
Heat (7)(2)	Floor With Def. Bleed	4	Closed	Open	Bleed	Open(1)
Def. (7)(2)	Defroster With Floor Bleed	4	Closed	Bleed	Open	Open(1)

(1) - Recirculating Door is in Recirc. position.
(2) - Indeterminate
(3) - A/C Compressor is OFF
(4) - A/C Compressor is ON
(5) - Water valve closes in full "COOL" temperature lever position.
(6) - Speeds are reduced by approximately 2.0 Volts.
(7) - Recirculating Door is in Outside position.

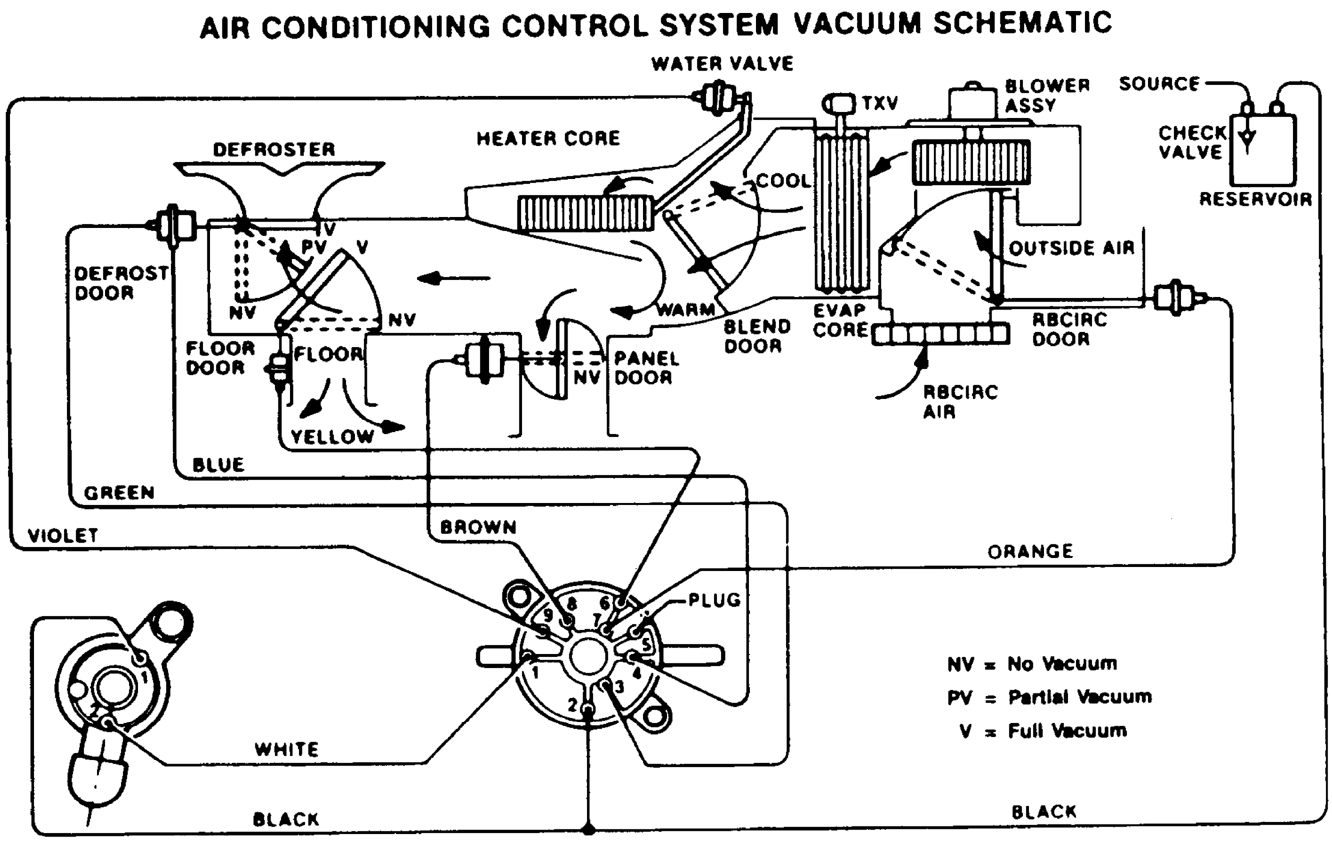


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Fig. 7: A/C Control System Vacuum Diagram

* A/C-HEATER SYSTEM UNIFORM INSPECTION GUIDELINES *

1988 Jeep Cherokee

GENERAL INFORMATION
A/C-Heater System Motorist Assurance Program
Standards For Automotive Repair

All Makes and Models

INTRODUCTION TO MOTORIST ASSURANCE PROGRAM (MAP)

CONTENTS

HEATER HOSES
HIGH PRESSURE RELIEF VALVES (HPRV)
IDLERS
IN-LINE FILTERS
METAL FITTINGS
METAL LINES
MIX AND AIR CONTROL DOORS (BLEND DOORS)
O-RINGS
ORIFICE TUBES
PILOT-OPERATED ABSOLUTES (POAS)
PLENUMS
PRESSURE CONTROL VALVES
PRESSURE SENSORS
PULLEYS
RADIATORS
RECEIVER-DRIERS
REFRIGERANT
REFRIGERANT OIL
RELAYS
SEALS
SERVICE PORTS
SPRING LOCK COUPLINGS
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THERMISTORS AND PRESSURE SENSORS
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WIRING HARNESSES AND CONNECTORS

MOTORIST ASSURANCE PROGRAM (MAP)

OVERVIEW

The Motorist Assurance Program is the consumer outreach effort of the Automotive Maintenance and Repair Association, Inc. (AMRA). Participation in the Motorist Assurance Program is drawn from retailers, suppliers, independent repair facilities, vehicle manufacturers and industry associations.

Our organization’s mission is to strengthen the relationship between the consumer and the auto repair industry. We produce materials that give motorists the information and encouragement to take greater responsibility for their vehicles-through proper, manufacturer-recommended, maintenance. We encourage participating service and repair shops (including franchisees and dealers) to adopt (1) a Pledge of Assurance to their Customers and (2) the Motorist Assurance Program Standards of Service. All participating service providers have agreed to subscribe to this Pledge and to adhere to the promulgated Standards of Service demonstrating to their customers that they are serious about customer satisfaction.

These Standards of Service require that an inspection of the vehicle’s (problem) system be made and the results communicated to the customer according to industry standards. Given that the industry did not have such standards, the Motorist Assurance Program successfully promulgated industry inspection communication standards in 1994-95 for the following systems: Exhaust, Brakes, ABS, Steering and Suspension, Engine Maintenance and Performance, HVAC, and Electrical Systems. Further, revisions to all of these inspection communication standards

are continually republished. In addition to these, standards for Drive Train and Transmissions have recently been promulgated. Participating shops utilize these Uniform Inspection & Communication Standards as part of the inspection process and for communicating their findings to their customers.

The Motorist Assurance Program continues to work cooperatively and proactively with government agencies and consumer groups toward solutions that both benefit the customer and are mutually acceptable to both regulators and industry. We maintain the belief that industry must retain control over how we conduct our business, and we must be viewed as part of the solution and not part of the problem. Meetings with state and other government officials (and their representatives), concerned with auto repair and/or consumer protection, are conducted. Feedback from these sessions is brought back to the association, and the program adjusted as needed.

To assure auto repair customers recourse if they were not satisfied with a repair transaction, the Motorist Assurance Program offers mediation and arbitration through MAP/BBB-CARE and other non-profit organizations. MAP conducted pilot programs in twelve states before announcing the program nationally in October, 1998. During the pilots, participating repair shops demonstrated their adherence to the Pledge and Standards and agreed to follow the UICS in communicating the results of their inspection to their customers. To put some "teeth" in the program, an accreditation requirement for shops was initiated. The requirements are stringent, and a self-policing method has been incorporated which includes the "mystery shopping" of outlets.

We welcome you to join us as we continue our outreach... with your support, both the automotive repair industry and your customers will reap the benefits. Please visit MAP at our Internet site www. motorist.org or contact us at:

1444 I Street, NW Suite 700
Washington, DC 20005
Phone (202) 712-9042 Fax (202) 216-9646
January 1999

MAP UNIFORM INSPECTION GENERAL GUIDELINES

OVERVIEW OF SERVICE REQUIREMENTS & SUGGESTIONS

It is MAP policy that all exhaust, brake, steering, suspension, wheel alignment, drive-line, engine performance and maintenance, and heating, ventilation and air conditioning, and electrical services be offered and performed under the standards and procedures specified in these sections.

Before any service is performed on a vehicle, an inspection of the appropriate system must be performed. The results of this inspection must be explained to the customer and documented on an inspection form. The condition of the vehicle and its components will indicate what services/part replacements may be "Required" or "Suggested". In addition, suggestions may be made to satisfy the requests expressed by the customer.

When a component is suggested or required to be repaired or replaced, the decision to repair or replace must be made in the customer’s best interest, and at his or her choice given the options available.

This section lists the various parts and conditions that indicate a required or suggested service or part replacement. Although this list is extensive, it is not fully inclusive. In addition to this list, a technician may make a suggestion. However, any suggestions must be based on substantial and informed experience,

or the vehicle manufacturer's recommended service interval and must be documented.

Some conditions indicate that service or part replacement is required because the part in question is no longer providing the function for which it is intended, does not meet a vehicle manufacturer's design specification or is missing.

Example:
An exhaust pipe has corroded severely and has a hole in it through which exhaust gases are leaking. Replacement of the exhaust pipe in this case is required due to functional failure.

Example:
A brake rotor has been worn to the point where it measures less than the vehicle manufacturer's discard specifications. Replacement of the rotor is required because it does not meet design specifications.

Some conditions indicate that a service or part replacement is suggested because the part is close to the end of its useful life or addresses a customer's need, convenience or request. If a customer's vehicle has one of these conditions, the procedure may be only to suggest service.

Example:
An exhaust pipe is rusted, corroded or weak, but no leaks are present. In this case, the exhaust pipe has not failed. However, there is evidence that the pipe may need replacement in the near future. Replacement of the pipe may be suggested for the customer's convenience in avoiding a future problem.

Example:
The customer desires improved ride and/or handling, but the vehicle's shocks or struts have not failed. In this case, replacement may be suggested to satisfy the customer's wishes. In this case, replacement of the shocks or struts may not be sold as a requirement.

A customer, of course, has the choice of whether or not a shop will service his or her vehicle. He or she may decide not to follow some of your suggestions. When a repair is required, a MAP shop must refuse partial service on that system if, in the judgment of the service provider, proceeding with the work could create or continue an unsafe condition. When a procedure states that required or suggested repair or replacement is recommended, the customer must be informed of the generally acceptable repair/replacement options whether or not performed by the shop.

When presenting suggested repairs to the customer, you must present the facts, allowing the customer to draw their own conclusions and make an informed decision about how to proceed.

The following reasons may be used for required and suggested services. These codes are shown in the "Code" column of the MAP Uniform Inspection & Communications Standards that follow:

Reasons to Require Repair or Replacement

A - Part no longer performs intended purpose
B - Part does not meet a design specification (regardless of performance)
C - Part is missing

NOTE: When a repair is required, the shop must refuse partial

service to the system in question, if the repair creates or continues an unsafe condition.

Reasons to Suggest Repair or Replacement

1 - Part is close to the end of its useful life (just above discard specifications, or weak; failure likely to occur soon, etc.)
2 - To address a customer need, convenience, or request (to stiffen ride, enhance performance, eliminate noise, etc.)
3 - To comply with maintenance recommended by the vehicle's Original Equipment Manufacturer (OEM)
4 - Technician's recommendation based on substantial and informed experience

NOTE: Suggested services are always optional. When presenting suggested repairs to the customer, you must present the facts, allowing the customer to draw their own conclusions and make an informed decision about how to proceed.

HEATING, VENTILATION, AND AIR CONDITIONING

SERVICE PROCEDURES REQUIRED AND SUGGESTED FOR PROPER VEHICLE OPERATION

CAUTION: Before working on any air conditioning system, be sure to review current local, state, federal, and EPA regulations regarding charging, recycling, and disposal of refrigerant.

ACCUMULATORS

ACCUMULATOR INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Beyond vehicle manufacturer's service interval	3	Suggest replacement.
Dessicant at the end of its useful life (saturated with moisture)	1	Suggest repair or replacement.
Dessicant bag deteriorated	A	(1) Require replacement. Further inspection required.
Leaking	A	Require repair or replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.
Tubing connection leaking	A	Require repair or replacement.

(1) - Inspect system to determine effects of dessicant bag deterioration.

ACTUATORS (ELECTRICAL)

ACTUATOR (ELECTRICAL) INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Connector broken	A	Require repair or replacement.
Connector (Weatherpack type) leaking	A	Require repair or replacement.
Connector melted, affecting performance	A	(1) Require repair or replacement.
Connector melted, not affecting performance	2	(1) Suggest repair or replacement.
Connector missing	C	Require replacement.
Inoperative	A	(2) Require replacement.
Missing	C	Require replacement.
Noisy	2	Suggest repair or replacement.
Out of adjustment	B	Require repair or replacement.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(1) Require repair or replacement.
Terminal burned, not affecting performance	1	(1) Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	1	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.

ACTUATORS (VACUUM)

ACTUATOR (VACUUM) INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of

		hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Connector broken	A	Require repair or replacement.
Connector (Weatherpack type) leaking	A	Require repair or replacement.
Connector melted, affecting performance	A	(1) Require repair or replacement.
Connector melted, not affecting performance	2	(1) Suggest repair or replacement.
Connector missing	C	Require replacement.
Inoperative	A	(2) Require replacement.
Leaking (vacuum)	A	Require repair or replacement.
Linkage bent, affecting performance	A	Require repair or replacement of linkage.
Linkage bent, not affecting performance	2	Suggest repair or replacement of linkage.
Linkage binding, affecting performance	A	Require repair or replacement of linkage.
Linkage binding, not affecting performance	1	Suggest repair or replacement of linkage.
Linkage broken	A	Require repair or replacement of linkage.
Linkage loose, affecting performance	A	Require repair or replacement of linkage.
Linkage loose, not affecting performance	1	Suggest repair or replacement of linkage.
Linkage missing	C	Require replacement.
Linkage noisy	2	Suggest repair or replacement.
Missing	C	Require replacement.
Noisy	2	Suggest repair or replacement.
Out of adjustment	A	Require repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - Inoperative includes intermittent operation or out of OEM specification.

AIR CONDITIONING FITTINGS

See
AIR CONDITIONING METAL LINES, HOSES AND FITTING ASSEMBLIES .

AIR CONDITIONING HOSES

See
AIR CONDITIONING METAL LINES, HOSES AND FITTING ASSEMBLIES .

AIR CONDITIONING METAL LINES, HOSES AND FITTING ASSEMBLIES

AIR CONDITIONING METAL LINE, HOSE AND FITTING ASSEMBLY INSPECTION

Condition	Code	Procedure

Condition	Code	Procedure
Abrasion damage, affecting structural integrity	A	Require repair or replacement.
Abrasion damage, not affecting structural integrity	..	No service suggested or required.
Application incorrect	B	Require replacement.
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Clamp corroded, not reusable	1	Suggest replacement.
Connected incorrectly	A	Require repair.
Corroded, affecting structural integrity	A	Require replacement.
Corroded, not affecting structural integrity	..	No service suggested or required.
Cracked	A	Require repair or replacement.
Fitting type incorrect (such as compression fitting)	B	Require replacement.
Flange leaking	A	Require repair or replacement.
Insufficient clamping force, allowing hose to leak	A	Require repair or replacement.
Leaking	A	Require repair or replacement.
Melted	1	Suggest repair or replacement.
Missing	C	Require replacement.
Outer covering damaged to the extent that the inner fabric is visible	A	Require replacement.
Protective sleeves damaged	2	Suggest replacement of sleeves.
Protective sleeves missing	C	Require replacement of sleeves.
Restricted, affecting performance	A	Require repair or replacement.
Routed incorrectly	2	Require repair.
Swollen	1	Suggest replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.
Type incorrect	1	Suggest repair or replacement.

AIR CONTROL DOORS

See PLENUMS.

AIR DAMS (EXTERNAL)

AIR DAM (EXTERNAL) INSPECTION

Condition	Code	Procedure

Application incorrect, affecting air conditioning system performance	A	Require repair or replacement.
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Bent, affecting air conditioning system performance	A	Require repair or replacement.
Blocked, affecting air conditioning system performance	A	Require repair or replacement.
Broken, affecting air conditioning system performance	A	Require repair or replacement.
Cracked, affecting air conditioning system performance	A	Require repair or replacement.
Loose, affecting air conditioning system performance	A	Require repair.
Loose, not affecting air conditioning system performance	2	Suggest repair.
Missing, affecting air conditioning system performance	C	Require replacement.

AIR DISTRIBUTION SYSTEM

See PLENUMS.

BELTS

BELT INSPECTION

Condition	Code	Procedure
Alignment incorrect	B	(1) Further inspection required.
Cracked	1	Suggest replacement.
Frayed	1	Suggest replacement.
Missing	C	Require replacement.
Noisy	2	(2) Further inspection required.
Plies separated	A	Require replacement.
Serpentine belt routed incorrectly	B	Require repair.
Tension out of specification	B	Require adjustment or replacement.
Worn beyond adjustment range	B	Require replacement.

Worn so it contacts bottom of pulley	A	.... Require replacement.

(1) - Determine cause of incorrect alignment and require repair.
(2) - Determine cause of noise and suggest repair.

BLEND DOORS

See PLENUMS.

BLOWER FANS (BLOWER WHEEL OR SQUIRREL CAGE)

BLOWER FAN (BLOWER WHEEL OR SQUIRREL CAGE) INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	... Require repair or replacement of hardware.
Attaching hardware missing	C	.... Require replacement of hardware.
Attaching hardware not functioning	A	... Require repair or replacement of hardware.
Application incorrect ...	B	.. Require repair or replacement.
Broken	A	.... Require replacement.
Cracked	A	.... Require replacement
Distorted	A	.... Require replacement.
Fins missing	C	.... Require replacement.
Hub separated	A	.... Require replacement.
Inoperative	A	.... (1) Require replacement.
Mounting loose	A	.. Require repair or replacement.
Noisy	2	.... Suggest replacement.
Out of balance	A	.. Require repair or replacement.

(1) - Inoperative includes intermittent operation or out of OEM specification.

BLOWER MOTORS

BLOWER MOTOR INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	... Require repair or replacement of hardware.
Attaching hardware missing	C	.... Require replacement of hardware.
Attaching hardware not functioning	A	... Require repair or replacement of hardware.
Connector broken	A	.. Require repair or replacement.
Connector (Weatherpack type) leaking	A	.. Require repair or replacement.
Connector melted, affecting performance ..	A	.... (1) Require repair or replacement.
Connector melted, not		

Condition	Code	Procedure
affecting performance	2	(1) Suggest repair or replacement.
Connector missing	C	Require replacement.
Current draw out of specification	B	Require repair or replacement.
Inoperative	A	(2) Require replacement.
Missing	C	Require replacement.
Motor speed insufficient	2	Suggest repair or replacement.
Noisy	2	Suggest replacement.
Rotation incorrect for application	B	Require repair or replacement.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(1) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.
Vibration	1	Suggest replacement.
Wire lead conductors exposed	B	Require repair or replacement.
Wire lead corroded	A	Require repair or replacement.
Wire lead open	A	Require repair or replacement.
Wire lead shorted	A	Require repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - Check fan motor/controls. Inoperative includes intermittent operation or out of OEM specification.

BLOWER RESISTORS

BLOWER RESISTOR INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Conductor exposed	A	Require replacement.
Connector broken	A	Require repair or replacement.
Connector melted, affecting performance	A	(1) Require repair or replacement.
Connector melted, not affecting performance	1	(1) Suggest repair or replacement.

Connector missing	C	Require replacement.
Inoperative	A	(2) Require replacement.
Insulation overheated	A	Require replacement.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(1) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - Inoperative includes intermittent operation or out of OEM specification.

BLOWER SWITCHES

See SWITCHES.

CABIN AIR FILTERS

CABIN AIR FILTER INSPECTION

Condition	Code	Procedure
Air flow obstruction	A	Require cleaning or replacement.
Maintenance intervals	3	Suggest replacement.
Missing	C	Require replacement.

CIRCUIT BREAKERS

See FUSES, FUSIBLE LINKS AND CIRCUIT BREAKERS.

COMPRESSOR CLUTCH ASSEMBLIES

COMPRESSOR CLUTCH ASSEMBLY INSPECTION

Condition	Code	Procedure
Air gap incorrect	B	Require repair or replacement.
Bearing seized	A	Require replacement of bearing or assembly.
Bearing worn, affecting performance	A	Require replacement of bearing or assembly.
Coil shows signs of overheating	1	Suggest replacement of coil.
Connector broken	A	Require repair or replacement.
Connector (Weatherpack type) leaking	A	Require repair or replacement.
Connector melted,		

Condition	Code	Procedure
affecting performance	A	(1) Require repair or replacement.
Connector melted, not affecting performance	2	(1) Suggest repair or replacement.
Connector missing	C	Require replacement.
Hub broken	A	Require replacement.
Hub cracked	B	Require replacement.
Hub loose on shaft	A	Require replacement.
Hub scored, affecting performance	A	Require replacement.
Hub warped, affecting performance	A	Require replacement.
Inoperative	A	(2) Require repair or replacement.
Noisy	2	Suggest repair or replacement.
Slips	A	Require repair or replacement.
Terminal burned, affecting performance	A	(1) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.
Will not disengage	A	Require repair or replacement.
Wire lead burned	A	Require repair or replacement.
Wire lead conductors exposed	B	Require repair or replacement.
Wire lead open	A	Require repair or replacement.
Wire lead shorted	A	Require repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - Inoperative includes intermittent operation or out of OEM specification.

COMPRESSORS

COMPRESSOR INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Bracket bent, affecting performance	A	Require repair or replacement.
Bracket bent, not affecting performance	..	No service suggested or required.

Bracket broken, affecting performance	A	Require replacement.
Bracket broken, not affecting performance	..	No service suggested or required.
Bracket corroded, affecting performance	A	Require repair or replacement.
Bracket corroded, not affecting performance	2	Suggest repair or replacement.
Bracket cracked, affecting performance	A	Require repair or replacement.
Bracket cracked, not affecting performance	1	Suggest repair or replacement.
Bracket holes elongated, affecting performance	A	Require repair or replacement.
Bracket holes elongated, not affecting performance	..	No service suggested or required.
Bracket loose, affecting performance	A	Require repair or replacement.
Bracket loose, not affecting performance	1	Suggest repair or replacement.
Bracket missing	C	Require replacement.
Housing broken, affecting performance	A	Require repair or replacement.
Housing broken, not affecting performance	..	No service suggested or required.
Housing cracked, affecting performance	A	Require repair or replacement.
Housing cracked, not affecting performance	1	Suggest repair or replacement.
Inoperative	A	(1) Require repair or replacement.
Leaking	A	Require repair or replacement.
Noisy	2	(2) Suggest repair or replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.
Tubing connection leaking	A	Require repair or replacement.

(1) - Inoperative includes intermittent operation or out of OEM specification.
(2) - Compressor noise can also be caused by low oil level, state of charge, air contamination, or type of refrigerant.

CONDENSER AIR SEALS

CONDENSER AIR SEAL INSPECTION

Condition	Code	Procedure
Leaking	A	Require repair or replacement.
Missing	C	Require replacement.

CONDENSER FAN MOTORS

See COOLING FAN MOTORS.

CONDENSERS

CONDENSER INSPECTION

Condition	Code	Procedure
Abrasion damage, affecting structural integrity	A	Require repair or replacement.
Abrasion damage, not affecting structural integrity	..	No service suggested or required.
Air flow obstruction, affecting performance	A	Require repair or replacement.
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Bent, affecting performance	A	Require repair or replacement.
Bent, not affecting performance	..	No service suggested or required.
Bracket bent, affecting performance	A	Require repair or replacement.
Bracket bent, not affecting performance	..	No service suggested or required.
Bracket broken, affecting performance	A	Require replacement.
Bracket broken, not affecting performance	..	No service suggested or required.
Bracket corroded, affecting performance	A	Require repair or replacement.
Bracket corroded, not affecting performance	2	Suggest repair or replacement.
Bracket cracked, affecting performance	A	Require repair or replacement.
Bracket cracked, not affecting performance	1	Suggest repair or replacement.
Bracket holes elongated, affecting performance	A	Require repair or replacement.
Bracket holes elongated, not affecting performance	..	No service suggested or required.
Bracket loose, affecting performance	A	Require repair or replacement.
Bracket loose, not affecting performance	1	Suggest repair or replacement.
Bracket missing	C	Require replacement.
Corroded, affecting structural integrity	A	Require replacement.
Corroded, not affecting structural integrity	..	No service suggested or

		required.
Fitting type incorrect (such as compression fitting)	B	Require replacement.
Flange leaking	A	Require repair or replacement.
Leaking	A	Require repair or replacement.
Restricted internally	A	Require repair or replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.

CONNECTORS

See WIRING HARNESSES AND CONNECTORS.

CONTROL CABLES

CONTROL CABLE INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Binding	A	Require repair or replacement.
Bracket bent, affecting performance	A	Require repair or replacement.
Bracket bent, not affecting performance	..	No service suggested or required.
Bracket broken, affecting performance	A	Require replacement.
Bracket broken, not affecting performance	..	No service suggested or required.
Bracket corroded, affecting performance	A	Require repair or replacement.
Bracket corroded, not affecting performance	2	Suggest repair or replacement.
Bracket cracked, affecting performance	A	Require repair or replacement.
Bracket cracked, not affecting performance	1	Suggest repair or replacement.
Bracket holes elongated, affecting performance	A	Require repair or replacement.
Bracket holes elongated, not affecting performance	..	No service suggested or required.
Bracket loose, affecting performance	A	Require repair or replacement.
Bracket loose, not affecting performance	1	Suggest repair or replacement.
Bracket missing	C	Require replacement.
Broken	A	Require repair or replacement.
Cracked	2	Suggest repair or replacement.

Disconnected	A	Require repair or replacement.
Kinked	2	Suggest repair or replacement.
Melted	A	(1) Require repair or replacement.
Missing	C	Require replacement.
Out of adjustment	B	(2) Require repair or replacement.
Routed incorrectly	2	Suggest repair.
Seized	A	Require repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - Follow OEM recommended adjustment procedures. Require repair or replacement if out of specification.

CONTROL HEADS (FUNCTION SELECTORS)

CONTROL HEAD (FUNCTION SELECTOR) INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Connector broken	A	Require repair or replacement.
Connector (Weatherpack type) leaking	A	Require repair or replacement.
Connector melted, affecting performance	A	(1) Require repair or replacement.
Connector melted, not affecting performance	2	(1) Suggest repair or replacement.
Connector missing	C	Require replacement.
Contaminated	2	Suggest require replacement.
Leaking	A	Require repair or replacement.
Malfunctioning	A	(2) Require repair or replacement.
Melted, affecting performance	A	(1) Require repair or replacement.
Melted, not affecting performance	..	No service suggested or required.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(1) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.

Terminal loose, not affecting performance	..	1	Suggest repair or replacement.
Wire lead burned	....	A	Require repair or replacement.
Wire lead conductors exposed	....	B	Require repair or replacement.
Wire lead open	....	A	Require repair or replacement.
Wire lead shorted	....	A	Require repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - Includes inoperative, intermittent operation, or failure to perform all functions.

CONTROL LINKAGES

CONTROL LINKAGE INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Bent	A	Require repair or replacement.
Binding	A	Require repair or replacement.
Bracket bent, affecting performance	A	Require repair or replacement.
Bracket bent, not affecting performance ..	..	No service suggested or required.
Bracket broken, affecting performance	A	Require replacement.
Bracket broken, not affecting performance ..	..	No service suggested or required.
Bracket corroded, affecting performance ..	A	Require repair or replacement.
Bracket corroded, not affecting performance ..	2	Suggest repair or replacement.
Bracket cracked, affecting performance	A	Require repair or replacement.
Bracket cracked, not affecting performance ..	1	Suggest repair or replacement.
Bracket holes elongated, affecting performance ..	A	Require repair or replacement.
Bracket holes elongated, not affecting performance	..	No service suggested or required.
Bracket loose, affecting performance	A	Require repair or replacement.
Bracket loose, not affecting performance ..	1	Suggest repair or replacement.
Bracket missing	C	Require replacement.
Broken	A	Require replacement.
Cracked	A	Require repair or replacement.
Disconnected	A	Require repair or replacement.

Condition	Code	Procedure
Missing	C	Require replacement.
Noisy	2	Suggest repair or replacement.
Out of adjustment	B	(1) Require repair or replacement.
Seized	A	Require repair or replacement.

(1) - Follow OEM recommended adjustment procedures. Require repair or replacement if out of specification.

CONTROL MODULES

NOTE: Includes, but not limited to: IRCM, Coolant Fan Control Module (CFCM), AC Controller, Amplifier, Programmers, Control Heads, Power Modules, etc.

CONTROL MODULE INSPECTION

Condition	Code	Procedure
Application incorrect	B	Require replacement.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware threads damaged	A	Require repair or replacement of hardware.
Attaching hardware threads stripped (threads missing)	A	Require repair or replacement of hardware.
Code set (if applicable)	A	(1) Further inspection required.
Connector broken	A	Require repair or replacement.
Connector melted, affecting performance	A	(2) Require repair or replacement.
Connector melted, not affecting performance	2	(2) Suggest repair or replacement.
Connector missing	A	Require repair.
Contaminated	A	(3) Require repair or replacement.
Inoperative	B	(4) Require repair or replacement. Further inspection required.
Leaking	A	Require repair or replacement.
Missing	C	Require replacement.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(2) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.

Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.
Wire lead conductors exposed	B	Require repair or replacement.
Wire lead corroded	A	Require repair or replacement.
Wire lead open	A	Require repair or replacement.
Wire lead shorted	A	Require repair or replacement.

(1) - Refer to manufacturer's diagnostic trouble code procedure and require repair or replacement of affected component(s).
(2) - Determine cause and correct prior to repair or replacement of part.
(3) - Determine source of contamination, such as engine coolant, fuel, metal particles, or water. Require repair or replacement. Check for accepted cleaning procedure.
(4) - Inoperative includes intermittent operation or out of OEM specification. Some components may be serviceable.

COOLANT

COOLANT INSPECTION

Condition	Code	Procedure
Acidity (pH) incorrect	1	Suggest correction or replacement.
Contaminated	B	(1) Require replacement or recycling. Further inspection required.
Level incorrect	B	(2) Require filling to proper level.
Maintenance intervals	3	(3) Suggest replacement.
Mixture incorrect	B	Require correction or replacement.
Type incorrect	B	Require replacement.

(1) - Determine source of contamination and require correction prior to coolant replacement.
(2) - Determine source of incorrect level and suggest repair.
(3) - The system should be drained and/or flushed and refilled with correct coolant according to OEM recommended service interval and procedures.

COOLING FAN BLADES

COOLING FAN BLADE INSPECTION

Condition	Code	Procedure
Application incorrect	B	Require replacement.
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.

Bent	A	Require replacement.
Broken	A	Require replacement.
Cracked	A	Require replacement.
Loose	A	Require repair or replacement.
Missing	C	Require replacement.

COOLING FAN CLUTCHES

NOTE: Some lateral movement, measured at the fan blade tip, may be normal.

COOLING FAN CLUTCH INSPECTION

Condition	Code	Procedure
Application incorrect	B	Require replacement.
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Bearing noisy	A	Require replacement.
Bearing worn	A	Require replacement.
Fastener loose	A	Require repair or replacement of fastener.
Inoperative	A	(1) Require replacement.
Leaking	1	Suggest replacement.
Seized	A	Require replacement.
Slips (insufficient fan speed)	A	Require replacement.
Thermal control incorrect	B	Require repair or replacement.

(1) - Inoperative includes intermittent operation or out of OEM specification.

COOLING FAN MOTORS

COOLING FAN MOTOR INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Connector broken	A	Require repair or replacement.
Connector (Weatherpack type) leaking	A	Require repair or replacement.
Connector melted, affecting performance	A	(1) Require repair or replacement.

Connector melted, not affecting performance	2	(1) Suggest repair or replacement.
Connector missing	C	Require replacement.
Hydraulic fan motor leaking	A	Require repair or replacement.
Inoperative	A	(2) Require replacement.
Missing	C	Require replacement.
Noisy	2	Suggest replacement.
Rotation incorrect for application	B	Require repair or replacement.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(1) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.
Vibration	1	Suggest replacement.
Wire lead conductors exposed	B	Require repair or replacement.
Wire lead corroded	A	Require repair or replacement.
Wire lead open	A	Require repair or replacement.
Wire lead shorted	A	Require repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - Check fan motor/controls. Inoperative includes intermittent operation or out of OEM specification.

EVAPORATOR DRAIN TUBES

EVAPORATOR DRAIN TUBE INSPECTION

Condition	Code	Procedure
Disconnected	A	Require repair.
Leaking	A	Require replacement.
Missing	C	Require replacement.
Restricted	A	Require repair or replacement.
Routed incorrectly	B	Require repair.

EVAPORATOR PRESSURE REGULATORS (EPRS)

EVAPORATOR PRESSURE REGULATOR (EPR) INSPECTION

Condition	Code	Procedure
Inoperative	A	(1) Require repair or replacement.

(1) - Inoperative includes intermittent operation or out of OEM specification.

EVAPORATORS

EVAPORATOR INSPECTION

Condition	Code	Procedure
Abrasion damage, affecting structural integrity	A	Require repair or replacement.
Abrasion damage, not affecting structural integrity	..	No service suggested or required.
Air flow obstruction, affecting performance	A	Require repair or replacement.
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Bracket bent, affecting performance	A	Require repair or replacement.
Bracket bent, not affecting performance	..	No service suggested or required.
Bracket broken, affecting performance	A	Require replacement.
Bracket broken, not affecting performance	..	No service suggested or required.
Bracket corroded, affecting performance	A	Require repair or replacement.
Bracket corroded, not affecting performance	2	Suggest repair or replacement.
Bracket cracked, affecting performance	A	Require repair or replacement.
Bracket cracked, not affecting performance	1	Suggest repair or replacement.
Bracket holes elongated, affecting performance	A	Require repair or replacement.
Bracket holes elongated, not affecting performance	..	No service suggested or required.
Bracket loose, affecting performance	A	Require repair or replacement.
Bracket loose, not affecting performance	1	Suggest repair or replacement.
Bracket missing	C	Require replacement.
Corroded, affecting structural integrity	A	Require replacement.
Corroded, not affecting structural integrity	..	No service suggested or required.
Evaporator foam seal leaking	A	Require replacement.
Evaporator foam seal missing	C	Require replacement.
Fitting type incorrect		

Condition	Code	Procedure
(such as compression fitting)	B	Require replacement.
Flange leaking	A	Require repair or replacement.
Leaking	A	Require repair or replacement.
Restricted internally	A	Require repair or replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.

EXPANSION VALVES

EXPANSION VALVE INSPECTION

Condition	Code	Procedure
Application incorrect	B	Require replacement.
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Corroded internally	1	Suggest replacement.
Filter screen torn	A	Require replacement of screen.
Inoperative	A	(1) Require repair or replacement.
Leaking	A	Require replacement.
Restricted	A	Require repair or replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.

(1) - Expansion valve operation may be affected by capillary tube location, corrosion, and insulation tape. Inoperative includes intermittent operation.

FUNCTION SELECTORS

See CONTROL HEADS (FUNCTION SELECTORS).

FUSES, FUSIBLE LINKS AND CIRCUIT BREAKERS

FUSE, FUSIBLE LINK AND CIRCUIT BREAKER INSPECTION

Condition	Code	Procedure
Application incorrect	B	Require replacement.
Blown	A	(1) Require replacement.
Corroded, affecting performance	A	Require repair or replacement.
Corroded, not affecting performance	2	Suggest repair or replacement.
Cracked, affecting performance	A	Require repair or replacement.
Cracked, not affecting performance	1	Suggest repair or replacement.
Inoperative	A	(2) Require replacement.
Insulation damaged,		

conductors exposed	A	.. Require repair or replacement.
Insulation damaged, conductors not exposed .	1	.. Suggest repair or replacement.
Missing	C	.... Require replacement.
Routed incorrectly	B	.... Require repair.
Secured incorrectly	B	.... Require repair.
Terminal broken	A	.. Require repair or replacement.
Terminal burned, affecting performance	A	.... (1) Require repair or replacement.
Terminal burned, not affecting performance ..	2	.. Suggest repair or replacement.
Terminal corroded, affecting performance ..	A	.. Require repair or replacement.
Terminal corroded, not affecting performance ..	2	.. Suggest repair or replacement.
Terminal loose, affecting performance	B	.. Require repair or replacement.
Terminal loose, not affecting performance ..	1	.. Suggest repair or replacement.

(1) - Determine cause and correct prior to replacement of part.
(2) - Inoperative includes intermittent operation.

FUSIBLE LINKS

See FUSES, FUSIBLE LINKS AND CIRCUIT BREAKERS.

GASKETS

GASKET INSPECTION

Condition	Code	Procedure
Leaking	A	.... (1) Require repair or replacement.

(1) - Require inspection of mating and sealing surface and repair or replace as necessary.

HEATER CASES

See PLENUMS.

HEATER CONTROL VALVES

HEATER CONTROL VALVE INSPECTION

Condition	Code	Procedure
Application incorrect ...	B	.... Require replacement.
Attaching hardware broken	A	... Require repair or replacement of hardware.
Attaching hardware missing	C	.... Require replacement of hardware.
Attaching hardware not functioning	A	... Require repair or replacement

		of hardware.
Binding	2	Suggest repair or replacement.
Coolant leak	A	Require repair or replacement.
Disconnected	A	Require repair or replacement.
Malfunctioning	A	(1) Require repair or replacement.
Missing	C	Require replacement.
Restricted	A	Require repair or replacement.
Seized	A	Require repair or replacement.
Vacuum leak	A	Require repair or replacement.

(1) - Includes inoperative, intermittent operation, or failure to perform all functions.

HEATER CORES

HEATER CORE INSPECTION

Condition	Code	Procedure
Air flow obstruction	A	Require repair or replacement.
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Connection leaking	A	Require repair or replacement.
Corroded	1	Suggest repair or replacement.
Disconnected	A	Require repair or replacement.
Fins damaged, affecting performance	A	Require repair or replacement.
Fins damaged, not affecting performance	..	No service suggested or required.
Internal restrictions, affecting performance	A	Require repair or replacement.
Leaking	A	Require repair or replacement.
Missing	C	Require replacement.

HEATER HOSES

HEATER HOSE INSPECTION

Condition	Code	Procedure
Application incorrect	B	Require replacement.
Connected incorrectly	A	Require repair.
Corroded, not reusable	1	Suggest replacement.
Cracked	A	Require repair or replacement.
Hard (brittle)	1	Suggest repair or replacement.
Inner fabric (webbing) damaged	A	Require replacement.
Insufficient clamping force, allowing hose to leak	A	Require repair or replacement.
Leaking	A	Require repair or replacement.
Maintenance intervals	3	Suggest replacement.

Melted	1	Suggest repair or replacement.
Missing	C	Require replacement.
Outer covering damaged	1	Suggest replacement.
Outer covering damaged to the extent that the inner fabric is visible	A	Require replacement.
Protective sleeves damaged	2	Suggest replacement of sleeves.
Protective sleeves missing	2	Suggest replacement of sleeves.
Restricted, affecting performance	A	Require repair or replacement.
Restricted, not affecting performance	2	Suggest repair or replacement.
Routed incorrectly	2	Suggest repair.
Safety clip missing	C	Require replacement.
Spongy	1	Suggest repair or replacement.
Stripped	A	Require replacement.
Surface cracks (dry-rotted)	1	Suggest repair or replacement.
Swollen	B	Require replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.
Type incorrect	1	Suggest repair or replacement.

HIGH PRESSURE RELIEF VALVES (HPRV)

HIGH PRESSURE RELIEF VALVE (HPRV) INSPECTION

Condition	Code	Procedure
Inoperative	A	(1) Require repair or replacement.
Leaking	A	Require repair or replacement.
Missing	C	Require replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.

(1) - Inoperative includes intermittent operation or out of OEM specification.

IDLERS

See TENSIONERS.

IN-LINE FILTERS

IN-LINE FILTER INSPECTION

Condition	Code	Procedure
Connection leaking	B	Require repair or replacement.
Leaking	A	Require repair or replacement.
Restricted	A	Require replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.

METAL FITTINGS

See
AIR CONDITIONING METAL LINES, HOSES AND FITTING ASSEMBLIES.

METAL LINES

See
AIR CONDITIONING METAL LINES, HOSES AND FITTING ASSEMBLIES.

MIX AND AIR CONTROL DOORS (BLEND DOORS)

See PLENUMS.

O-RINGS

O-RING INSPECTION

Condition	Code	Procedure
Leaking	A	(1) Require repair or replacement.

(1) - Require inspection of mating and sealing surface and repair or replace as necessary.

ORIFICE TUBES

ORIFICE TUBE INSPECTION

Condition	Code	Procedure
Application incorrect	B	Require replacement.
Bypassing internally	A	Require repair or replacement.
Filter screen torn	A	Require replacement.
Installation incorrect	B	Require repair.
Restricted	A	Require repair or replacement.

PILOT-OPERATED ABSOLUTES (POAS)

PILOT-OPERATED ABSOLUTE (POA) INSPECTION

Condition	Code	Procedure
Connection damaged	B	Require repair or replacement.
Fitting damaged	B	Require repair or replacement.
Inoperative	A	(1) Require repair or replacement.
Leaking	A	Require repair or replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.

(1) - Inoperative includes intermittent operation or out of OEM specification.

PLENUMS

PLENUM INSPECTION

Condition	Code	Procedure
Air control door binding	A	Require repair or replacement
Air control door broken	A	Require repair or replacement.
Air control door leaking	A	Require repair or replacement.
Air control door seized	A	Require repair or replacement.
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Cracked	2	Suggest repair or replacement.
Drain hole restricted	A	Require repair.
Drain plugged	A	Require repair.
Duct disconnected	A	Require repair or replacement.
Duct leaking	A	Require repair or replacement.
Duct missing	C	Require replacement.
Duct restricted	A	Require repair or replacement.
Leaking	A	Require repair or replacement.
Noisy	2	Suggest cleaning or repair.
Odor	2	Suggest cleaning or repair.
Restricted	A	Require cleaning, repair, or replacement.

PRESSURE CONTROL VALVES

See:

* EVAPORATOR PRESSURE REGULATORS (EPRS)
* HIGH PRESSURE RELIEF VALVES (HPRV)
* PILOT-OPERATED ABSOLUTES (POAS)
* SUCTION THROTTLING VALVES (STVS)
* VALVES IN RECEIVER (VIRS)

PRESSURE SENSORS

See THERMISTORS AND PRESSURE SENSORS.

PULLEYS

PULLEY INSPECTION

Condition	Code	Procedure
Alignment incorrect	B	Require repair or replacement.
Application incorrect	B	Require replacement.
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not		

functioning	A	Require repair or replacement of hardware.
Bearing noisy	2	Suggest replacement.
Bearing seized	A	Require repair or replacement.
Bearing worn	1	Suggest replacement.
Cracked	A	Require replacement.
Loose	A	Require repair or replacement.
Missing	C	Require replacement.
Pulley damaged, affecting belt life	A	Require replacement.

RADIATORS

RADIATOR INSPECTION

Condition	Code	Procedure
Air flow obstruction	A	Require repair.
Application incorrect	B	Require replacement.
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Connection leaking	A	Require repair or replacement.
Corroded	1	Suggest repair or replacement.
Drain inoperative	A	Require repair or replacement.
Fins damaged, affecting performance	A	Require repair or replacement.
Fins damaged, not affecting performance		No service suggested or required.
Internal oil cooler leaking	A	Require repair or replacement.
Internal restrictions	B	Require repair or replacement.
Leaking	A	Require repair or replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require repair or replacement.
Tubes damaged, affecting performance	A	Require repair or replacement.
Tubes damaged, not affecting performance		No service suggested or required.

RECEIVER-DRIERS

NOTE: For VIRs, see VALVES IN RECEIVER (VIRS).

RECEIVER-DRIER INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware		

missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Contaminated, affecting performance	A	Require replacement.
Dessicant bag deteriorated	A	(1) Require replacement. Further inspection required.
Dessicant at the end of its useful life (saturated with moisture)	1	Suggest repair or replacement.
Fusible plug leaking	A	Require replacement of plug.
Leaking	A	Require replacement.
Pressure relief device leaking	A	Require replacement of pressure relief device.
Restricted	A	Require repair or replacement.
Sight glass no longer transparent	2	Suggest replacement of drier.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.
Tubing connection leaking	A	Require repair or replacement.

(1) - Inspect system to determine effects of dessicant bag deterioration.

REFRIGERANT

NOTE: Refrigerants include any SNAP (Significant New Alternative Policy)-approved blends.

REFRIGERANT INSPECTION

Condition	Code	Procedure
Contaminated (other than refrigerant blends)	B	Require service to remove contamination.
Different types of refrigerants in the same system (other than refrigerant blends)	B	Require repair.
Overcharged	B	Require repair.
Refrigerant type does not match fittings and label	B	Require repair.
Undercharged	B	Require repair.

REFRIGERANT OIL

REFRIGERANT OIL INSPECTION

Condition	Code	Procedure
Contaminated	1	Require repair or replacement.
Overfilled	B	Require repair.

Underfilled	B	Require repair.

RELAYS

RELAY INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Housing broken	A	Require replacement.
Housing cracked	2	Suggest replacement.
Inoperative	A	(1) Require replacement.
Melted, affecting performance	A	(2) Require repair or replacement.
Melted, not affecting performance	2	(2) Suggest repair or replacement.
Missing	C	Require replacement.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(2) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.

(1) - Inoperative includes intermittent operation or out of OEM specification.
(2) - Determine cause and correct prior to repair or replacement of part.

SEALS

SEAL INSPECTION

Condition	Code	Procedure
Leaking	A	(1) Require repair or replacement.

(1) - Require inspection of mating and sealing surface and repair or replace as necessary.

SERVICE PORTS

SERVICE PORT INSPECTION

Condition	Code	Procedure
Application does not match refrigerant type	B	Require replacement.
Leaking	A	Require repair or replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.
Valve cap leaking	A	Require repair or replacement of cap.
Valve cap missing	C	Require replacement of valve cap.
Valve core sticking	B	Require repair or replacement.

SPRING LOCK COUPLINGS

SPRING LOCK COUPLING INSPECTION

Condition	Code	Procedure
Leaking	A	(1) Require repair or replacement.

(1) - Require inspection of mating and sealing surface and repair or replace as necessary.

SUCTION THROTTLING VALVES (STVS)

SUCTION THROTTLING VALVE (STV) INSPECTION

Condition	Code	Procedure
Connection damaged	B	Require repair or replacement.
Fitting damaged	B	Require repair or replacement.
Inoperative	A	(1) Require repair or replacement.
Leaking	A	Require repair or replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.

(1) - Inoperative includes intermittent operation or out of OEM specification.

SWITCHES (ELECTRICAL)

SWITCH (ELECTRICAL) INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.

Attaching hardware not functioning	A	... Require repair or replacement of hardware.
Binding, affecting performance	A	.. Require repair or replacement.
Binding, not affecting performance	2	.. Suggest repair or replacement.
Broken	A	.. Require repair or replacement.
Burned, affecting performance	A	.... (1) Require repair or replacement.
Burned, not affecting performance	2	.... (1) Suggest repair or replacement.
Cracked, affecting performance	A	.. Require repair or replacement.
Cracked, not affecting performance	1	.. Suggest repair or replacement.
Malfunctioning	A	.... (2) Require repair or replacement.
Melted, affecting performance	A	.... (1) Require repair or replacement.
Melted, not affecting performance	2	.... (1) Suggest repair or replacement.
Missing	C	.... (3) Require replacement.
Out of adjustment	B	.. Require repair or replacement.
Pressure switch leaking .	A	.. Require repair or replacement.
Terminal broken	A	.. Require repair or replacement.
Terminal burned, affecting performance	A	.... (1) Require repair or replacement.
Terminal burned, not affecting performance ..	2	.. Suggest repair or replacement.
Terminal corroded, affecting performance ..	A	.. Require repair or replacement.
Terminal corroded, not affecting performance ..	2	.. Suggest repair or replacement.
Terminal loose, affecting performance	B	.. Require repair or replacement.
Terminal loose, not affecting performance ..	1	.. Suggest repair or replacement.
Threads damaged	A	.. Require repair or replacement.
Threads stripped (threads missing)	A	.... Require replacement.
Won't return	A	.. Require repair or replacement.
Worn	1	.... Suggest replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - Includes inoperative, intermittent operation, or failure to perform all functions.
(3) - Missing includes high pressure cut-off switches not installed during a retrofit from R12 to R134a.

TENSIONERS

TENSIONER INSPECTION

Condition	Code	Procedure

Alignment incorrect	B	Require repair or replacement.
Application incorrect	B	Require replacement.
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Bearing worn	1	Suggest replacement.
Belt tension incorrect	B	Require adjustment or repair.
Bracket cracked	A	Require repair or replacement.
Housing cracked	A	Require repair or replacement.
Missing	C	Require replacement.
Noisy	2	Suggest replacement.
Pulley damaged, affecting belt life	A	Require replacement.
Seized	A	Require repair or replacement.

THERMISTORS AND PRESSURE SENSORS

NOTE: Includes, but not limited to, In-Car Temperature, Ambient Air Temperature, Sun Load Sensor, etc.

THERMISTOR AND PRESSURE SENSOR INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Calibration incorrect	B	Require repair or replacement.
Connector broken	A	Require repair or replacement.
Connector (Weatherpack type) leaking	A	Require repair or replacement.
Connector melted, affecting performance	A	(1) Require repair or replacement.
Connector melted, not affecting performance	2	(1) Suggest repair or replacement.
Connector missing	C	Require replacement.
Inoperative	A	(2) Require repair or replacement.
Missing	C	Require replacement.
Terminal burned, affecting performance	A	(1) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.

Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.
Wire lead burned	A	Require repair or replacement.
Wire lead conductors exposed	B	Require repair or replacement.
Wire lead open	A	Require repair or replacement.
Wire lead shorted	A	Require repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - Inoperative includes intermittent operation or out of OEM specification.

THERMOSTATS AND HOUSINGS

THERMOSTAT AND HOUSING INSPECTION

Condition	Code	Procedure
Application incorrect	B	Require replacement.
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware corroded	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Cracked	A	Require replacement.
Housing corroded	1	Suggest replacement of housing.
Inoperative	A	(1) Require replacement.
Installation incorrect	B	Require repair or replacement.
Leaking	A	Require repair or replacement.
Thermostat missing	C	Require replacement of thermostat.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require repair or replacement.

(1) - Inoperative includes intermittent operation or out of OEM specification.

VACUUM HOSES AND TUBES

VACUUM HOSE AND TUBE INSPECTION

Condition	Code	Procedure
Disconnected	A	Require repair.
Leaking	A	Require repair or replacement.
Melted	A	Require repair replacement.
Missing	C	Require replacement.
Oil-soaked (spongy)	1	Suggest replacement.
Restricted	A	Require repair or replacement.

Routing incorrect	B	Require repair.
Surface cracks (dry-rotted)	1	Suggest replacement.

VACUUM RESERVOIRS

VACUUM RESERVOIR INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Check valve leaking internally	A	Require replacement.
Leaking	A	Require repair or replacement.
Missing	C	Require replacement.
Restricted	A	Require repair or replacement.

VACUUM TUBES

See VACUUM HOSES AND TUBES.

VALVES IN RECEIVER (VIRS)

VALVE IN RECEIVER (VIR) INSPECTION

Condition	Code	Procedure
Application incorrect	B	Require replacement.
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Bracket bent, affecting performance	A	Require repair or replacement.
Bracket bent, not affecting performance	..	No service suggested or required.
Bracket broken, affecting performance	A	Require replacement.
Bracket broken, not affecting performance	..	No service suggested or required.
Bracket corroded, affecting performance	A	Require repair or replacement.
Bracket corroded, not affecting performance	2	Suggest repair or replacement.
Bracket cracked, affecting performance	A	Require repair or replacement.

Bracket cracked, not affecting performance	1	Suggest repair or replacement.
Bracket holes elongated, affecting performance	A	Require repair or replacement.
Bracket holes elongated, not affecting performance	..	No service suggested or required.
Bracket loose, affecting performance	A	Require repair or replacement.
Bracket loose, not affecting performance	1	Suggest repair or replacement.
Bracket missing	C	Require replacement.
Connection damaged	B	Require repair or replacement.
Contaminated, affecting performance	A	Require replacement.
Corroded internally	1	Suggest replacement.
Dessicant bag deteriorated	A	(1) Require replacement. Further inspection required.
Dessicant at the end of its useful life (saturated with moisture)	1	Suggest repair or replacement.
Filter screen torn	A	Require replacement of screen.
Fitting damaged	B	Require repair or replacement.
Fusible plug leaking	A	Require replacement of plug.
Inoperative	A	(2) Require repair or replacement.
Leaking	A	Require repair or replacement.
Pressure relief device leaking	A	Require replacement of pressure relief device.
Restricted	A	Require repair or replacement.
Sight glass no longer transparent	2	Suggest replacement of drier.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.
Tubing connection leaking	A	Require repair or replacement.

(1) - Inspect system to determine effects of dessicant bag deterioration.
(2) - Inoperative includes intermittent operation or out of OEM specification.

WATER PUMPS (ELECTRIC AUXILIARY)

WATER PUMP (ELECTRIC AUXILIARY) INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.

Connector broken	A	Require repair or replacement.
Connector (Weatherpack type) leaking	A	Require repair or replacement.
Connector melted, affecting performance	A	(1) Require repair or replacement.
Connector melted, not affecting performance	2	(1) Suggest repair or replacement.
Connector missing	C	Require replacement.
Inoperative	A	(2) Require replacement.
Leaking	A	Require repair or replacement.
Missing	C	Require replacement.
Noisy	2	Suggest replacement.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(1) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.
Vibration	1	Suggest replacement.
Wire lead conductors exposed	B	Require repair or replacement.
Wire lead corroded	A	Require repair or replacement.
Wire lead open	A	Require repair or replacement.
Wire lead shorted	A	Require repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - Inoperative includes intermittent operation or out of OEM specification.

WIRING HARNESSES AND CONNECTORS

WIRING HARNESS AND CONNECTOR INSPECTION

Condition	Code	Procedure
Application incorrect	B	Require repair or replacement.
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Connector broken	A	Require repair or replacement.
Connector (Weatherpack type) leaking	A	Require repair or replacement.
Circuit open	A	Require repair or replacement.
Circuit resistance (voltage drop) out of		

specification	A	Require repair or replacement.
Circuit shorted	A	Require repair or replacement.
Connector melted, affecting performance	A	(1) Require repair or replacement.
Connector melted, not affecting performance	2	(1) Suggest repair or replacement.
Connector missing	C	Require replacement.
Diode open	A	Require repair or replacement.
Diode shorted	A	Require repair or replacement.
Insulation damaged, conductors exposed	A	Require repair or replacement.
Insulation damaged, conductors not exposed	1	Suggest replacement.
Protective shield (conduit) melted	B	(1) Require replacement.
Protective shield (conduit) missing	C	Require replacement.
Routed incorrectly	B	Require repair.
Secured incorrectly	B	Require repair.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(1) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.
Voltage drop out of specification	A	Require repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.

A/C SYSTEM DIAGNOSIS

1988 Jeep Cherokee

1988 AIR CONDITIONING & HEAT
A/C General Servicing
Diagnostic Procedures

Jeep; All Models

DIAGNOSTIC PROCEDURES

Diagnosis is an important first step in A/C system servicing. To save time and effort, systems should be carefully checked to identify the causes of poor performance. By using the following diagnostic charts, defective components or system damage can be quickly located. To identify problems that are specific to one system, refer to the repair section of this manual. The charts in this section apply to all systems.

PREPARATION FOR TESTING

1) Attach Low and High side gauges.
2) Start engine and allow it to warm up.
3) Set system to COOL and blower to HIGH.
4) Open car doors and hood.
5) Run at fast idle for 2-3 minutes.

ALTITUDE PRESSURE VARIATIONS TABLE

ALTITUDE PRESSURE VARIATIONS TABLE

Altitude (Ft.Above Sea Level)	Absolute Pressure Of Atmosphere (psi)	Gauge Altitude Correction (1) (psi)
0	14.7	0
1000	14.2	0.5
2000	13.7	1.0
3000	13.2	1.5
4000	12.7	2.0
5000	12.2	2.5
6000	11.7	3.0
7000	11.3	3.4
8000	10.9	3.8
9000	10.5	4.2
10,000	10.1	4.6

(1) - Add correction shown from gauge readings

ALTITUDE VACUUM VARIATIONS TABLE

ALTITUDE VACUUM VARIATIONS TABLE

Altitude (Ft.Above Sea Level)	Complete Vacuum (In. Hg)	Gauge Altitude Correction (1) (In. Hg)
0	29.92	0
1000	28.92	1.0

2000	27.82	2.1
3000	26.82	3.1
4000	25.82	4.1
5000	24.92	5.0
6000	23.92	6.0
7000	23.02	6.9
8000	22.22	7.7
9000	21.32	8.6
10,000	20.52	9.4

(1) - Add correction shown to gauge readings

OPERATIONAL TEST GAUGE READINGS
Normal System Operating Pressures (PSI) (1)

Application	Low Side Gauge (Suct.)	High Side Gauge (Disc.)
Jeep 1980-87		
(Thermostatic Switch)	5-24	208-250
1988		
(Accumulator Type)	24-50	160-250

(1) - Pressure readings given are for a system in good operating condition, at sea level and an ambient temperature of 80°F (27°C).

AIR CONDITIONING SYSTEM PERFORMANCE CHECK TABLE

PERFORM TESTS:	SHOULD BE:	IF:
Temperature Check		Temperature Check is
* Switch to LOW blower * Close doors * Check outlet temperature.	35-45°F (1.7-7.2°C)	Too warm-Check control lever operation, heater water valve, cooling system and gauge readings.
Visual Check		Visual Check Shows:
* Compressor	Quiet, no leaks	Noisy-Check belts, oil level, seals, gaskets, reed valves.
* Condenser	Free of obstructions	Blocked-Clean off. Plugged-Flush or replace.
* Receiver-Drier	Dry and warm to touch.	Frosty-Check for restriction, replace desiccant.
* Sight Glass	Clear or few bubbles	Bubbly, foamy or streaks-Check gauge readings.
* High Side	Dry and warm to touch.	Frosty or very hot-Check for restriction or overcharge.
* Low Side Lines	Dry and cool to touch.	Frosty or warm-Check for restriction, low charge or bad valve.

* Expansion Valve	Dry	Frosty-Check for moisture or restriction. Check sensing bulb.
* STV	Dry and cool to touch.	Frosty or warm-Check gauge readings for valve malfunction
* Evaporator	Dry and cold to touch.	Freezing or warm-Check expansion valve, STV or thermo switch.
Gauge Readings		Gauge Readings are
* High Side Gauge	See Pressure Chart	Above or below normal-See A/C Diagnosis on next page.
* Low Side Gauge	See Pressure Chart	Above or below normal-See A/C Diagnosis on next page.

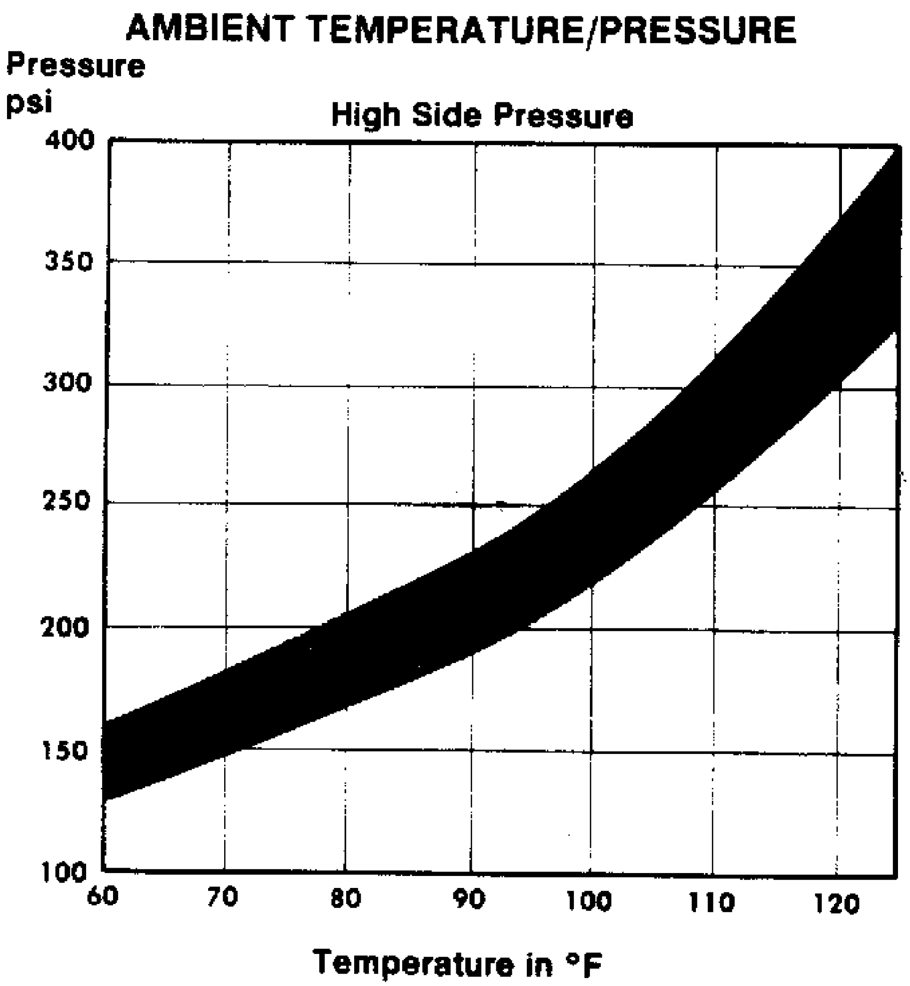

Fig. 1: AMBIENT TEMPERATURE/PRESSURE

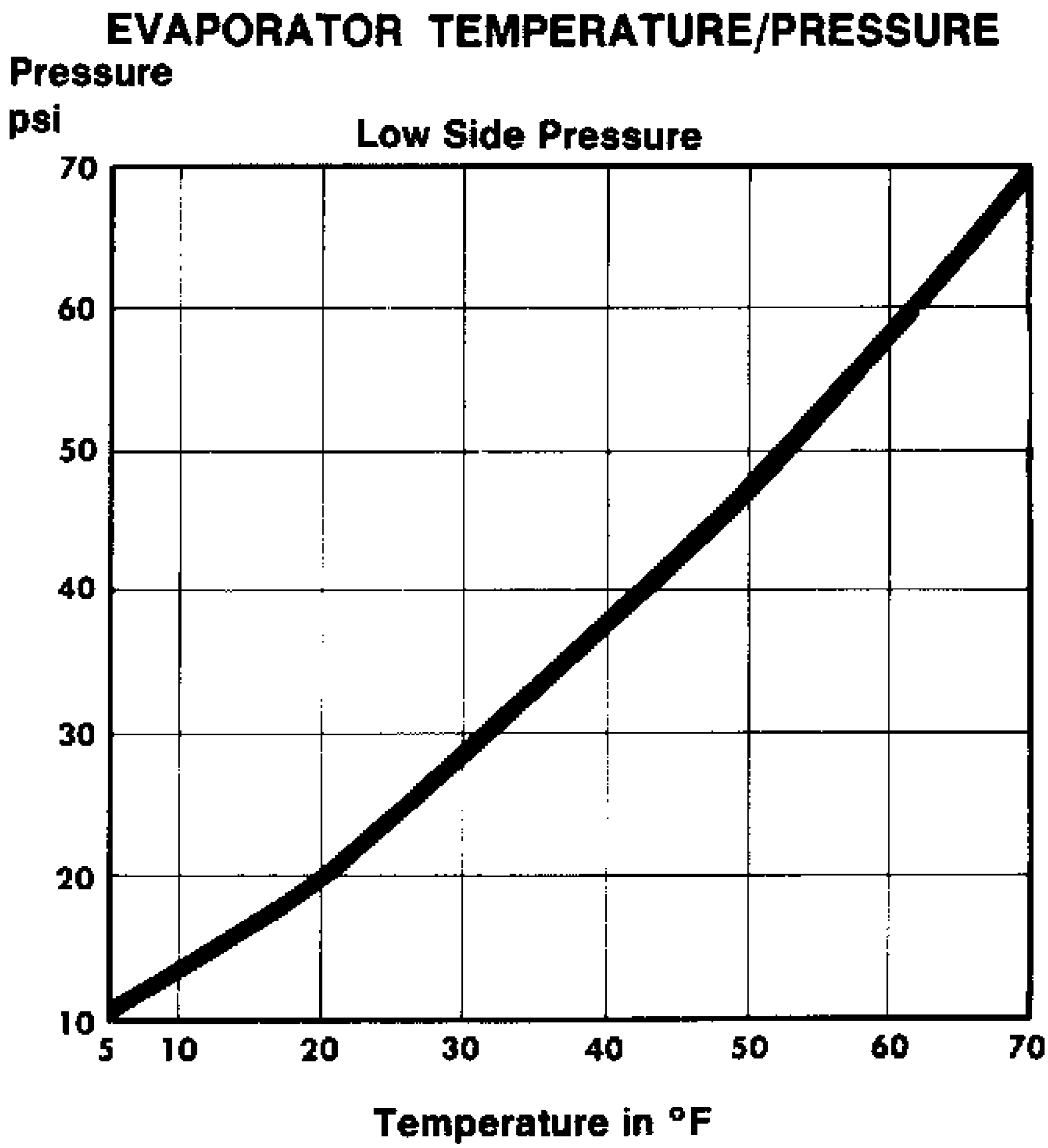

Fig. 2: EVAPORATOR TEMPERATURE/PRESSURE

AIR CONDITIONING DIAGNOSIS WITH GAUGES FOR SYSTEMS WITH INSUFFICIENT OR NO COOLING

LOW SIDE GAUGE	HIGH SIDE GAUGE	OTHER SYMPTOMS (1)	DIAGNOSIS
Normal	Normal	No or few bubbles in sight glass. High side gauge may go high. Low side gauge does not fluctuate with compressor on/off cycle.	Some Air and Moisture in System.
Normal	Normal	Cools okay in morning but not during hot part of day. Tiny bubbles in sight glass.	Excessive Moisture

		Discharge air warm when low side gauge drops into vacuum.	
Normal	Normal	Thermostatic switch system only-compressor cycles off and on too rapidly.	Defective Thermo- static Switch
Normal	Normal	Cycling clutch systems only-Compressor doesn't turn on soon enough. Discharge air becomes warm as low side pressure rises.	Misadjusted Thermo- static Switch or or Defective Pressure Sensing Switch
Low	Low	Bubbles in sight glass. Outlet air slightly cool.	Low R-12 Charge
Low	Low	Sight glass clear or oil- streaked. Outlet air very warm.	Excessively Low R-12 Charge
Low	Low	Outlet air slightly cool. Sweating or frost at at expansion valve.	Expansion Valve Stuck Closed. Screen Plugged or Sensing Bulb Malfunction.
Low	Low	Outlet air slightly cool. High side line cool to touch. Sweating or frost on high side.	Restriction on High Side
Low	High	Evaporator outlet pipe cold. Low side goes into vacuum when blower is disconnected.	STV Stuck Open
High	Low	Evaporator outlet pipe warm. Outlet air warm.	STV Stuck Open
High	Low	Noise from compressor.	Compressor Malfunction
High	High	Outlet air warm. Liquid line very hot. Bubbles in sight glass.	Condenser Malfunction or R-12 Overcharge.
High	High	Outlet air slightly cool. Bubbles in sight glass.	Large Amount of Air and Moisture in System.
High	High	Outlet air warm. Evaporator outlet sweating and frost.	Expansion Valve Stuck Open

(1) - If equipped with a low refrigerant charge protection system, compressor operation may have stopped.

A/C SYSTEM GENERAL SERVICING

1988 Jeep Cherokee

1988 AIR CONDITIONING & HEAT
A/C General Servicing
Diagnostic Procedures

Eagle & Jeep

* PLEASE READ THIS FIRST *

CAUTION: When discharging air conditioning system, use only approved refrigerant recovery/recycling equipment. Make every attempt to avoid discharging refrigerant into the atmosphere.

INTRODUCTION

This article is to be used for general service and diagnosis. For specific repair or replacement procedures, use the appropriate repair article in this section.

R-12 REFRIGERANT - SAFETY PRECAUTIONS

1) Always work in a well-ventilated, clean area. Refrigerant (R-12) is heavier than oxygen, and will displace oxygen in a confined area. Always wear eye protection when working around air conditioning systems and R-12. The system's high pressure can cause severe injury to eyes and skin if a hose were to burst. R-12 evaporates quickly when exposed to atmosphere, freezing anything it contacts.

2) Use care when handling refrigerant containers. Do not drop or strike containers. Do not expose refrigerant containers to excessive heat. Containers must never be heated more than 125°F. Never expose R-12 directly to open flame.

CAUTION: When R-12 is exposed to an open flame, drawn into a running engine, or detected with a Halide (propane) leak tester, poisonous phosgene gas is formed. Keep work areas ventilated and keep vehicles with running engines away.

USING INDIVIDUAL R-12 CANS

Disposable refrigerant cans (referred to as one pound cans) have a flat type seal or a screw type seal, and the proper can tap must be used for each type. Be sure sealing gasket on can tap is in good condition. A proper safety can tap will prevent refrigerant from flowing back into open can, as the tap has a one-way flow control.

NOTE: Recent findings by the EPA indicate that R-11, R-12 and R-113 are harmful to the Earths' protective Ozone layer. Make every attempt possible, to avoid discharging R-11, R-12 or R-113 into the atmosphere.

USING MULTI-CAN DISPENSING VALVES

A multi-can dispensing valve allows the attachment of several cans of refrigerant, and is a good substitute when a bulk container is not available. Cans are installed onto each leg of the multi-can dispensing valve in the same manner as the individual cans, and each leg has its own can tap.

CAN TAP INSTALLATION

FLAT TYPE SEAL CANS

On cam-lock or one-piece can taps, first turn the handle out to the fully open position. Securely engage the locking lugs over the flange of the can, and lock them in place by turning the cam lock or locking nut. Screw the tap assembly into the adapter so the sealing gasket is fully seated against the can top. Turn the tap inward to pierce the can and close the tap. DO NOT open the tap until ready to purge the service hose or dispense refrigerant into the system.

On 2-piece can taps, be certain the tap handle is turned fully in, so it is closed. Check that the locking base is turned to its outer limit. Securely engage the locking lugs over the can flange. Turn the entire tap assembly (without disturbing the closed setting) down into the locking base to pierce the can. Do not open the tap until ready to dispense into system.

SCREW TYPE SEAL CANS

Ensure can tap is fully closed. Screw refrigerant can into can tap fitting until tight. This will pierce the can. Connect tap to center hose on manifold gauge set. DO NOT open tap until ready to dispense R-12 into system.

WARNING: DO NOT open high side hand valve while air conditioning system is in operation. This high pressure could rupture can or possibly burst fitting at safety can valve, resulting in damage and physical injury.

COMPRESSOR OIL CHECK

GENERAL PROCEDURES

Some models have compressor-mounted service valves that allow oil checking by isolating the compressor. On all others, system must be discharged, using approved refrigerant recovery/recycling equipment, and compressor may need to be removed to check oil. After oil level is checked and adjusted, A/C system must be evacuated and recharged.

ISOLATING COMPRESSOR

1) Connect manifold gauge set to service valves on the compressor. Close both gauge valves. Open both service valves to themid-position.

2) Start engine and operate air conditioning. Turn suction service valve slowly clockwise toward front-seated position. When suction pressure is reduced to zero or less, stop engine and quickly close suction service valve (front-seated).

3) Front-seat the discharge valve. Loosen oil check plug slowly to release any internal pressure. Service valves can now be removed from compressor and compressor removed from vehicle (if necessary). Purge compressor after servicing.

PURGING COMPRESSOR

1) Remove gauge set and place caps on service valve ports. Back-seat the suction service valve to allow refrigerant to enter compressor.

2) Loosen discharge port valve slightly. Loosen valve port cap to allow refrigerant to force out air from compressor. Back-seat the discharge valve and tighten the port cap. Compressor is ready for service.

REFRIGERATION OIL

Only new, pure, moisture-free refrigeration oil should be used in the air conditioning system. This oil is highly refined and dehydrated (moisture content less than 10 parts per million).

Refrigeration oil container must be kept tightly closed at all times when not in use, or moisture will be absorbed from the air and introduced into the refrigeration system.

NIPPONDENSO 10-CYLINDER

SHAFT SEAL

NOTE: Check compressor refrigerant oil level when replacing seals. See COMPRESSOR REFRIGERANT OIL CHECKING article in this section.

Removal

1) Hold clutch hub stationary and remove center nut. Screw remover into center of hub. Turn center bolt to remove pressure plate.

2) Remove shims from shaft. Remove snap ring from inside of pulley. Tap pulley off of shaft with plastic mallet. Be careful not to distort pulley while removing.

3) Disconnect clutch coil wires from compressor housing. Remove snap ring inside coil and lift coil off compressor. Pry dust seal out from around compressor shaft (if equipped).

4) Place shaft key remover on shaft and turn to remove key. Remove drain plug (if equipped). Remove bolts holding service valves to body of compressor and remove valves. Discard "O" rings. Drain oil out of compressor.

5) Remove 6 through bolts from front head of compressor and discard washers. Tap head loose from compressor, being careful not to scratch sealing surfaces. Remove snap ring (if equipped) from front housing. Press seal plate out. Remove seal from shaft. See Fig. 1.

Installation

1) Lubricate shaft seal with clean refrigerant oil. Place on compressor shaft. Lubricate seal plate (and "O" ring, if equipped) and install in front housing. Install snap ring (if equipped).

2) Place front housing on compressor body. Using new washers, install through bolts. Tighten bolts evenly and alternately to 18 ft. lbs. (24 N.m). Install shaft key with installer and plastic mallet. Insert dust seal into front of compressor.

3) Install drain plug using new gasket. Add correct amount of refrigerant oil to compressor. If service valves were removed, coat new "O" rings with refrigerant oil and install service valves.

4) Place clutch coil on compressor and install snap ring. Install shims on shaft to adjust clearance between pressure plate and rotor to .016-.028" (.41-.71 mm). Tighten shaft nut to 12 ft. lbs. (16 N.m). See REFRIGERANT OIL & R-12 SPECIFICATIONS table for system capacities.

SANKYO/SANDEN 5-CYLINDER COMPRESSOR SERVICING

NOTE: During the past year, Sankyo International (USA), Inc. has changed its name to Sanden International (USA), Inc.

Information pertaining to Sanden compressors in this article, will be found in earlier articles under Sankyo compressors.

AMERICAN MOTORS & JEEP WITH 5-CYLINDER COMPRESSOR

Compressor Overhaul

1) After the compressor and system have been run, stop the engine. Slowly discharge system using approved refrigerant recovery/recycling equipment. Clean and cool dipstick with R-12.

2) Loosen the compressor mounting bolts, remove the drive belt, and move the compressor to a bench for easiest and most accurate measurement. Position the compressor so that the oil fill plug is at top dead center.

3) Thoroughly clean the oil fill plug and the area around it. Loosen the fill plug slowly to allow trapped refrigerant pressure to escape through the loosened threads.

4) The front plate hub has a lobe, which is indexed (notched) 180° from TDC of the cam rotor. Rotate the hub plate lobe until the index notch is 110° from bottom center. See Fig. 1. Check this position by looking through the oil fill hole and noting that the ball end of the top piston rod lines up with the fill hole.

5) Looking at the front end of the compressor, insert the dipstick diagonally from upper left to lower left until the dipstick stop contacts the filler hole surface. Remove dipstick and note oil level. Oil level should be between the 4th and 6th increment on the dipstick (3-4 ounces). Add oil as necessary.

Compressor Replacement

If system was opened by a leak or so quickly that oil was lost, install new compressor with all the oil it contains. If system was opened slowly and oil was not lost, drain oil from new compressor and measure. Reinstall 6 ounces of oil back into new compressor prior to installation.

Component Replacement

If a hose, receiver-drier, condenser, expansion valve or evaporator core requires replacement, add 1 ounce of new oil for each new component installed.

Compressor Oil Check

1) Discharge system, using approved refrigerant recovery/recycling equipment, or isolate compressor. Remove oil filler plug. Look through oil filler plug hole and rotate clutch front plate to position piston connecting rod in center of oil filler plug hole.

2) Insert dipstick (J-29642-12) through oil filler plug hole to the right of piston connecting rod until dipstick stop contacts the compressor housing.

3) Remove dipstick and count number of increments covered with oil. If compressor is properly filled, oil will cover 4-6 increments on the dipstick. Adjust oil level as necessary.

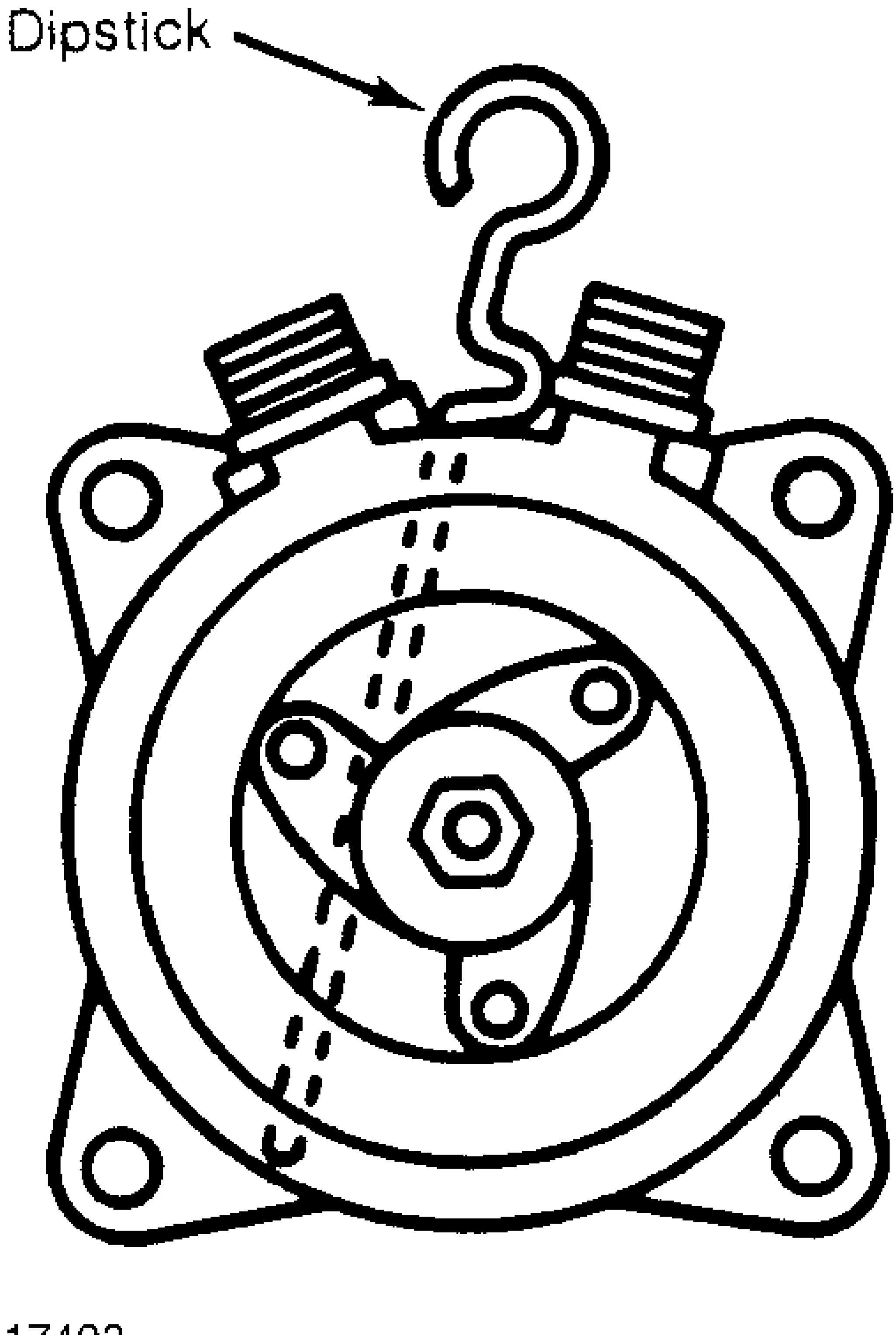

Fig. 1: 5-Cylinder Compressor Oil Check (Use dipstick J-29642-12)

YORK 2-CYLINDER COMPRESSOR SERVICING

JEEP WITH 2-CYLINDER COMPRESSOR

Isolating Compressor

1) Connect manifold gauge set to service valves on compressor. Close both gauge valves. Open both service valves to the mid-position.

2) Start engine and operate air conditioning. Turn suction service valve slowly clockwise toward front-seated position. When suction pressure is reduced to zero or less, stop engine and quickly close suction service valve (front-seated).

3) Front-seat the discharge valve. Loosen oil check plug slowly to release any internal pressure. Service valves can now be removed from compressor and compressor removed from vehicle (if necessary). Purge compressor after servicing.

Purging Compressor

1) Remove gauge set and place caps on service valve ports. Back-seat the suction service valve to allow refrigerant to enter compressor.

2) Loosen discharge port valve slightly. Loosen valve port cap to allow refrigerant to force out air from compressor. Back-seat the discharge valve and tighten the port cap. Compressor is ready for service.

Compressor Oil Check

1) Operate system for 10 minutes, then stop and isolate compressor. Loosen filler plug slowly to release any pressure in crankcase.

2) Use dipstick to check oil level. See Fig. 2. Add oil as necessary. Install plug with new "O" ring. Purge compressor of air.

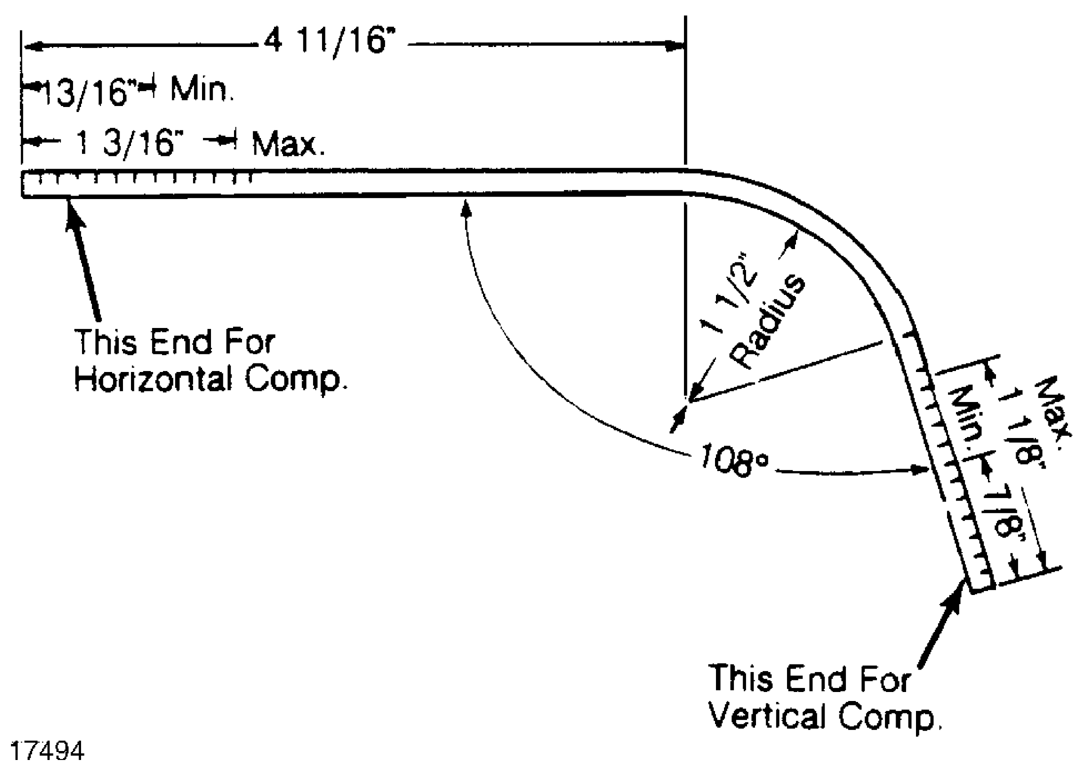

Fig. 2: York Compressor Oil Level Dipstick
Check oil with shaft keyway facing head.

SYSTEM SERVICING CAUTIONS

BEFORE OPENING THE SYSTEM

Before disconnecting any lines or fittings, the system must be completely discharged using approved refrigerant recovery/recycling equipment.

DISCONNECTING LINES & FITTINGS

1) After system is discharged, carefully clean entire area around coupling nut to prevent dirt entering system. Always use two wrenches to avoid twisting or distorting lines and fittings (hold fitting with one wrench while loosening coupling nut with second wrench).

2) Ford spring-coupling fittings require a special coupling tool (Motorcraft YT-1056) to open or close. See procedure under CONNECTING LINES & FITTINGS.

3) Cap or plug all LINES and FITTINGS immediately to prevent entry of air and moisture into the system. Do not remove these caps until connections are being made.

COMPONENT REPLACEMENT

When components are replaced, system oil level must be adjusted. Add refrigeration oil to replacement component. See Compressor Oil Check article, as well as, Component Oil Replacement Quantities" chart under A/C SYSTEM SERVICE SPECIFICATIONS in this article.

CONNECTING LINES & FITTINGS

All Except Ford Spring-Coupling Fitting

1) A new "O" ring should be used in all instances when connecting lines and fittings (dip "O" ring in clean refrigeration oil and make certain it is not twisted during installation). Always use two wrenches to avoid twisting or distorting lines and fittings. Tighten coupling nuts securely.

2) Ford spring-coupling fittings require a special coupling tool (Motorcraft YT-1056) to open or close. Use the following procedure to connect or disconnect the spring-coupling fitting.

Ford Spring-Coupling Fitting

1) Discharge system using approved refrigerant recovery/recycling equipment. Place proper end of tool over refrigerant line. Tool fits both 3/8" and 1/2" fittings. Push tool into fitting cage to release spring inside. Pull lines apart and remove tool.

2) Before connecting, check internal spring for damage. If Necessary, pry spring out and replace it. Clean fittings and install new "O" rings.

CAUTION: Use ONLY "O" rings designed for these Ford fittings (Motorcraft YF-982). Normal refrigerant "O" rings will NOT seal.

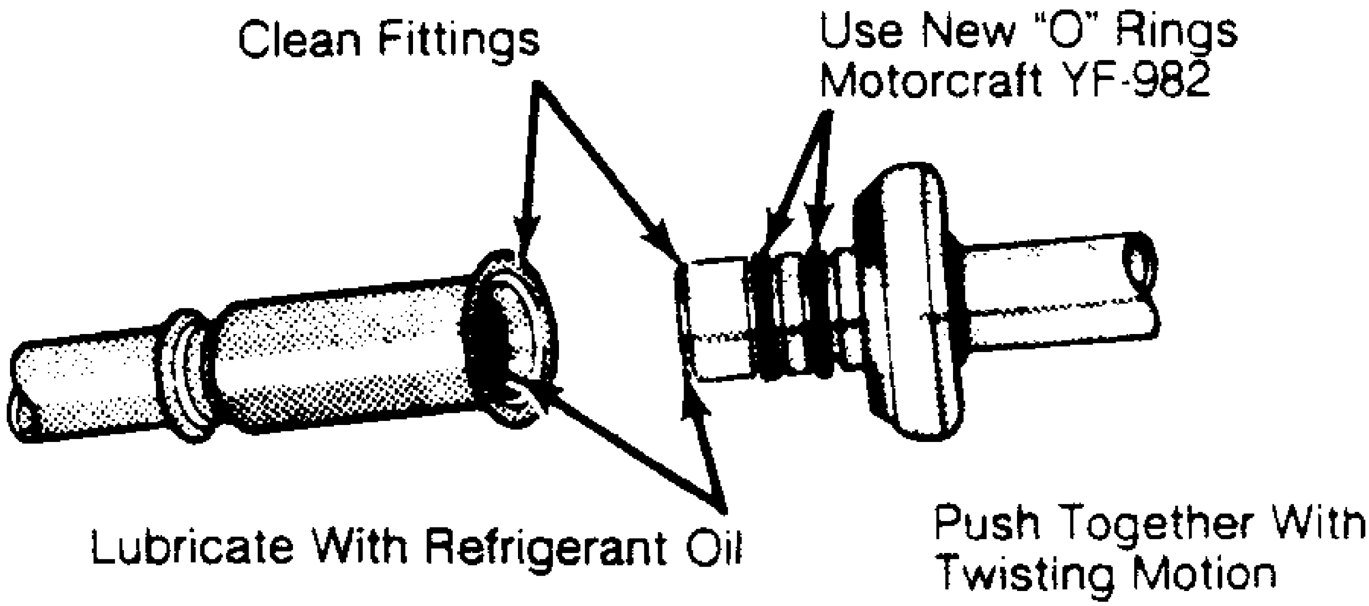

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Fig. 3: Assembling Ford Spring-Coupling Fitting

3) Lubricate both sides of fitting with clean refrigeration oil. Assemble the fitting by pushing together with a slight twisting motion. Check to make sure spring is over flared end of female fitting.

PLACING SYSTEM IN OPERATION

After component replacement and/or system servicing has been completed and all connections have been made, proceed as follows:

1) Evacuate the system using vacuum pump.
2) Charge the system with R-12. See REFRIGERANT CAPACITY in the A/C SYSTEM SERVICE SPECIFICATIONS in this article.
3) Leak test the system, with particular attention to all new connections and components.
4) Make a performance test of the system. Never assume that a recharging has automatically corrected a problem.

DIAGNOSTIC PROCEDURES

Diagnosis is an important first step in A/C system servicing. To save time and effort, systems should be carefully checked to identify the causes of poor performance. By using the following diagnostic charts, defective components or system damage can be quickly located. To identify problems that are specific to one system, refer to the repair sections of this article. The charts in this article apply to all systems.

PREPARATION FOR TESTING

1) Attach Low and High side gauges.
2) Start engine and allow it to warm up.
3) Set system to COOL and blower to HIGH.
4) Open car doors and hood.
5) Run at fast idle for 2-3 minutes.

ALTITUDE PRESSURE VARIATIONS

ALTITUDE PRESSURE VARIATIONS

Altitude (Ft. Above Sea Level)	Absolute Pressure of Atmosphere (psi)	Gauge Altitude Correction (1) (psi)
0	14.7	0
1000	14.2	-0.5
2000	13.7	-1.0
3000	13.2	-1.5
4000	12.7	-2.0
5000	12.2	-2.5
6000	11.7	-3.0
7000	11.3	-3.4
8000	10.9	-3.8
9000	10.5	-4.2
10,000	10.1	-4.6

(1) - Subtract correction shown from gauge readings.

ALTITUDE VACUUM VARIATIONS

Altitude (Ft. Above Sea Level)	Complete Vacuum (In. Hg)	Gauge Altitude Correction (In. Hg)
0	29.92	0
1000	28.92	+1.0
2000	27.82	+2.1
3000	26.82	+3.1
4000	25.82	+4.1
5000	24.92	+5.0
6000	23.92	+6.0
7000	23.02	+6.9
8000	22.22	+7.7
9000	21.32	+8.6
10,000	20.52	+9.4

(1) - Add correction shown to gauge readings.

OPERATIONAL TEST GAUGE READINGS
Normal System Operating Pressures (PSI) (1)

Application	Low Side Gauge (Suction)	High Side Gauge (Discharge)
Thermostatic Switch	5-24	208-250

(1) - Pressure readings given are for a system in good operating condition, at sea level and an ambient temperature of 80°F (27°C).

A/C SYSTEM PERFORMANCE CHECK TABLE

AIR CONDITIONING SYSTEM PERFORMANCE CHECK

PERFORM TESTS:	SHOULD BE:	IF:
Temperature Check		Temperature Check Is

* Switch to LOW blower.		
* Close doors.		Too warm - Check control lever operation, heater water valve, cooling system and gauge readings.
* Check outlet temperature.	35-45°F (1.7-7.2°C)	
Visual Check		Visual Check Shows:
* Compressor	Quiet, No Leaks	Noisy - Check belts, oil level, seals, gaskets, reed valves.
* Condenser	Free of Obstructions	Blocked - Clean off. Plugged - Flush or replace.
* Receiver-Drier	Dry and warm to touch	Frosty - Check for re-striction, replace Desicant.
* Sight Glass	Clear or few bubbles	Bubbly, foamy or streaks - Check gauge readings.
* High Side Lines	Dry and warm to touch	Frosty or very hot - Check for restriction or overcharge.
* Low Side Lines	Dry and cool to touch	Frosty or warm - Check for restriction, low charge or bad valve.
* Expansion Valve	Dry	Frosty - Check for moisture or restriction. Check sensing bulb.
* STV	Dry and cool to touch	Frosty or warm - Check gauge readings for valve malfunction.
* Evaporator	Dry and cold to touch	Freezing or warm - Check expansion valve, STV or thermo switch.
Gauge Readings		Gauge Readings are:
* High Side Gauge	See Pressure Chart	Above or below normal - See A/C DIAGNOSIS.
* Low Side Gauge	See Pressure Chart	Above or below normal - See A/C DIAGNOSIS.

PRESSURE CHARTS

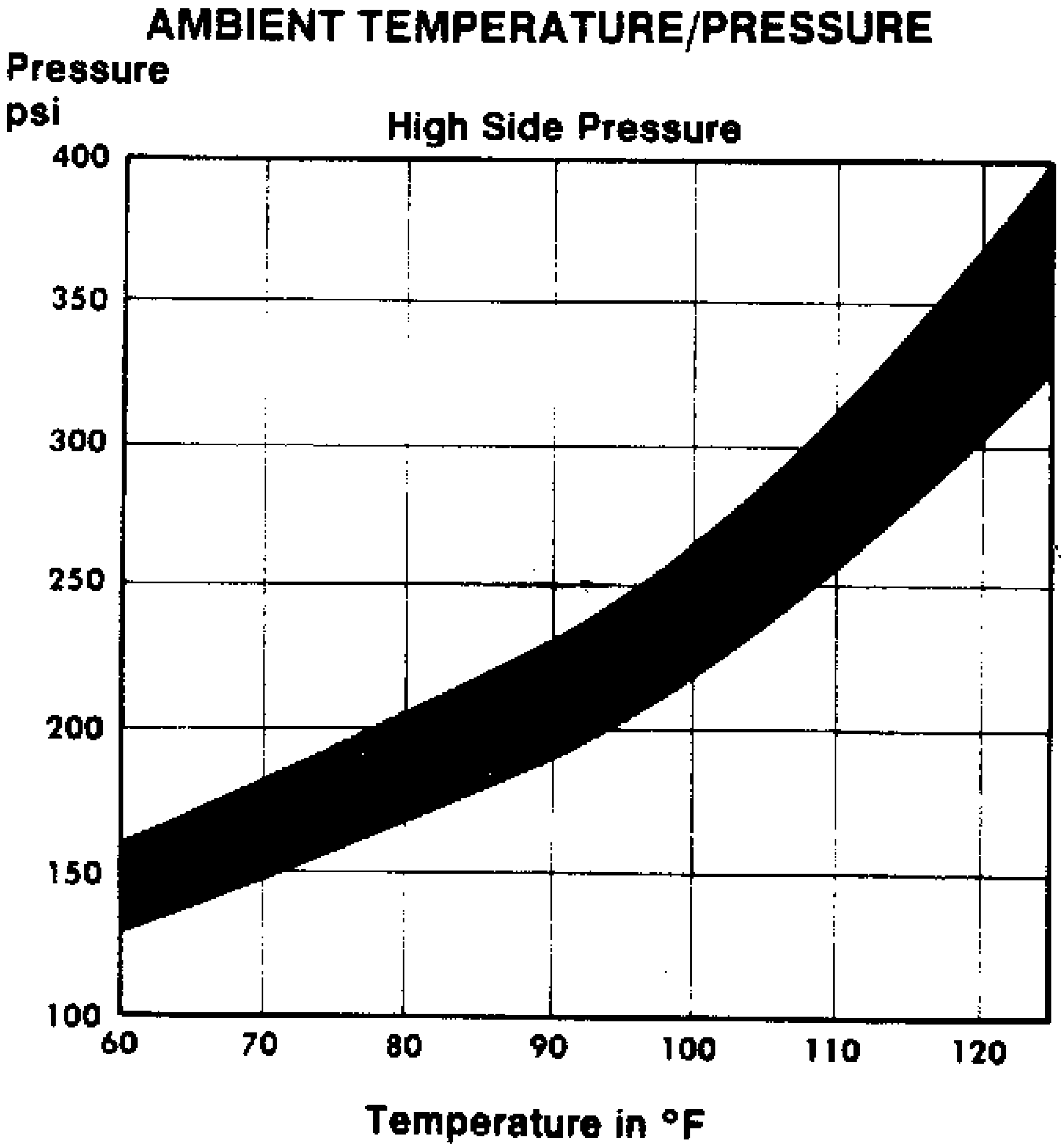


Fig. 4: Ambient Temperature/Pressure

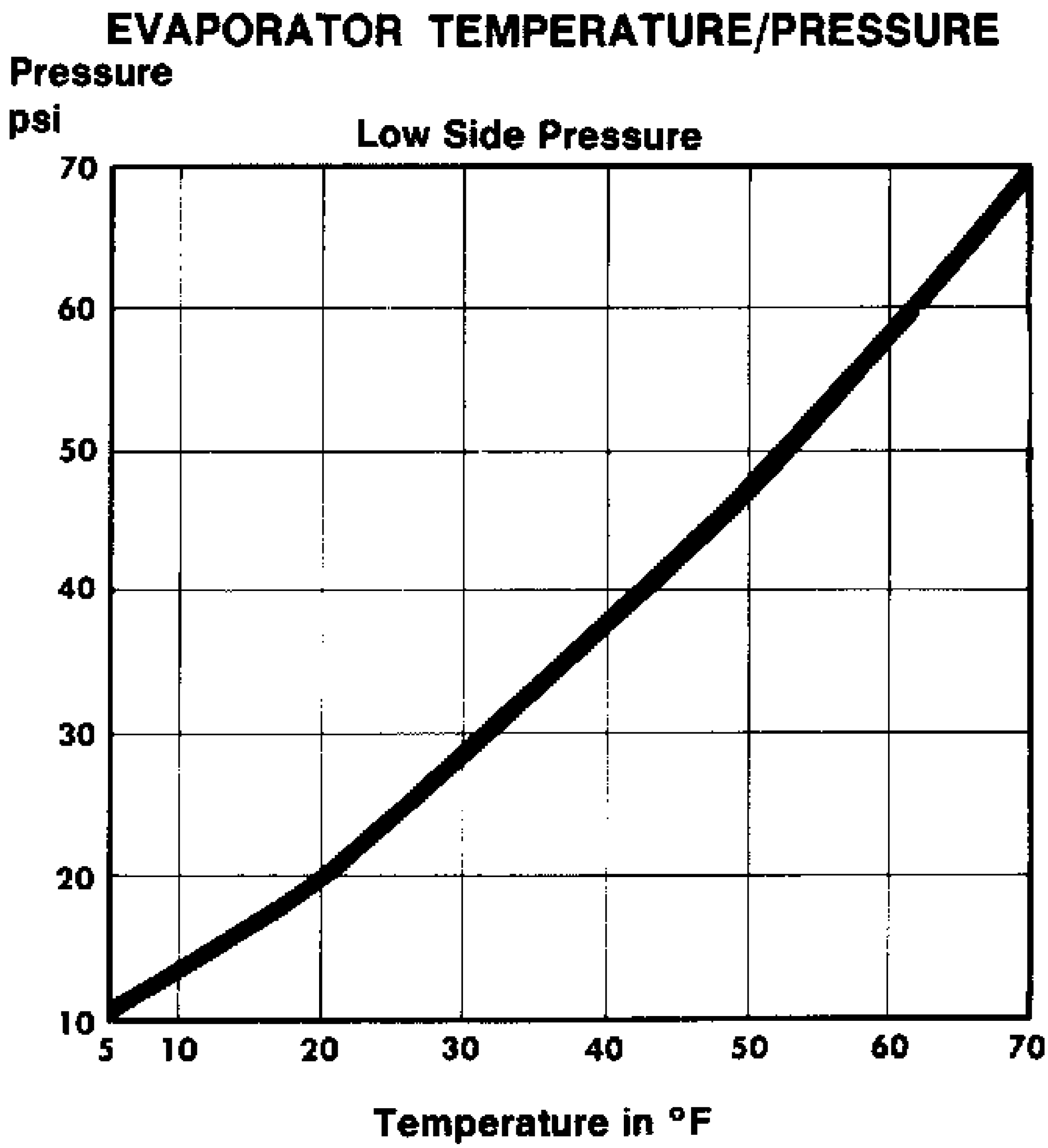


Fig. 5: Evaporator Temperature/Pressure

A/C SYSTEM DIAGNOSIS WITH GAUGES

DIAGNOSIS WITH GAUGES - SYSTEMS WITH INSUFFICIENT OR NO COOLING

LOW SIDE GAUGE	HIGH SIDE GAUGE	OTHER SYMPTOMS(1)	DIAGNOSIS
Normal	Normal	No or few bubbles in sight glass. High side gauge may go high. Low side gauge does not fluctuate with compressor on/off cycle.	Some Air and Moisture in System
Normal	Normal	Cools okay in morning but not during hot part of day.	Excessive Moisture in System

		Tiny bubbles in sight glass. Discharge air warm when low side gauge drops into vacuum.	
Normal	Normal	Thermostatic switch system only-compressor cycles off and on too rapidly.	Defective Thermo- static Switch
Normal to High	Normal	Cycling clutch systems only-Compressor doesn't turn on soon enough. Discharge air becomes warm as low side pressure rises.	Misadjusted Thermo static Switch or Defective Pressure Sensing Switch
Low	Low	Bubbles in sight glass. Outlet air slightly cool.	Low R-12 Charge
Low	Low	Sight glass clear or oil- streaked. Outlet air very warm.	Excessively Low R-12 Charge
Low	Low	Outlet air slightly cool. Sweating or frost at expansion valve.	Expansion Valve Stuck Closed. Screen Plugged or Sensing Bulb Malfunction
Low	Low	Outlet air slightly cool. High side line cool to touch. Sweating or frost on high side.	Restriction on High Side.
Low	High	Evaporator outlet pipe cold. Low side goes into vacuum when blower is disconnected.	STV Stuck Open
High	Low	Evaporator outlet pipe warm. Outlet air warm.	STV Stuck Open
High	Low	Noise from compressor	Compressor Malfunction
High	High	Outlet air warm. Liquid line very hot. Bubbles in sight glass.	Condenser Malfunction or R-12 Overcharge
High	High	Outlet air slightly cool. Bubbles in sight glass.	Large Amount of Air and Moisture in System.
High	High	Outlet air warm. Evaporator outlet sweating and frost.	Expansion Valve Stuck Open.

(1) - If equipped with a low refrigerant charge protection system, compressor operation may have stopped.

A/C SYSTEM SERVICE SPECIFICATIONS

REFRIGERANT OIL & R-12 CAPACITY TABLE

Application	(1) Oil Ounces	R-12 Ounces
Eagle	5.7	36

(1) - Total system capacity, unless otherwise noted.

SYSTEM REFRIGERANT CAPACITIES

Application	Pounds	Ounces
Eagle		
Medallion & Premier	1 7/8	29
Summit (FX105V)	2 1/4	36
Jeep		
CJ Models	2 1/2	40
Comanche	2	32
All Other Jeep Models	2 1/4	36

COMPONENT OIL REPLACEMENT QUANTITIES

Component	Ounces
Accumulator	(1)
Condenser	1
Evaporator	1
Receiver-Drier	1
Compressor	
Premier	(1)
Medallion	5.7
Grand Wagoneer	8
All Other Jeep Models	7

(1) - Add amount drained plus 1 ounce.

COMPRESSOR BELT TENSION (Lbs.) (1)

Application	New Belt	Used Belt
Eagle		
1.4L & 1.7L	120-160	90-115
Jeep		
Regular Belt	125-155	90-115
Serpentine Belt	180-200	140-160

(1) - Using standard strand tension gauge.

COOLING SYSTEM CAPACITIES (1)

Application	Quarts (Liters)
Eagle	
Medallion & Premier	
With A/C	4.8 (4.5)

Without A/C	4.4 (4.2)
Jeep	
Cherokee & Wagoneer (2)	
4-Cylinder	10.0 (9.5)
V6	12.0 (11.4)
CJ & Scrambler	
4-Cylinder	9.0 (8.5)
6-Cylinder	10.5 (9.9)
Grand Wagoneer & Truck (3)	
6-Cylinder	12.5 (11.8)
V8	15.5 (14.7)

(1) - May vary +/- 15% due to system variations.
(2) - Includes 2.3 qts. (2.2L) in recovery bottle.
(3) - Includes 1 qt. (.9L) for heater.

AIR CLEANER - THERMOSTATIC

1988 Jeep Cherokee

1988 Exhaust Emission Systems
JEEP THERMOSTATIC AIR CLEANER

DESCRIPTION

On models equipped with carburetor, a system for pre-heating air entering carburetor is used. This system is part of the air cleaner and maintains air temperature at a point where carburetor can be calibrated at leaner setting to reduce hydrocarbon emissions and improve driveability during warm-up.

These systems are vacuum-operated and consist of heat shroud on exhaust manifold, hot air duct, thermal sensor switch, vacuum motor, air valve assembly and reverse delay valve.

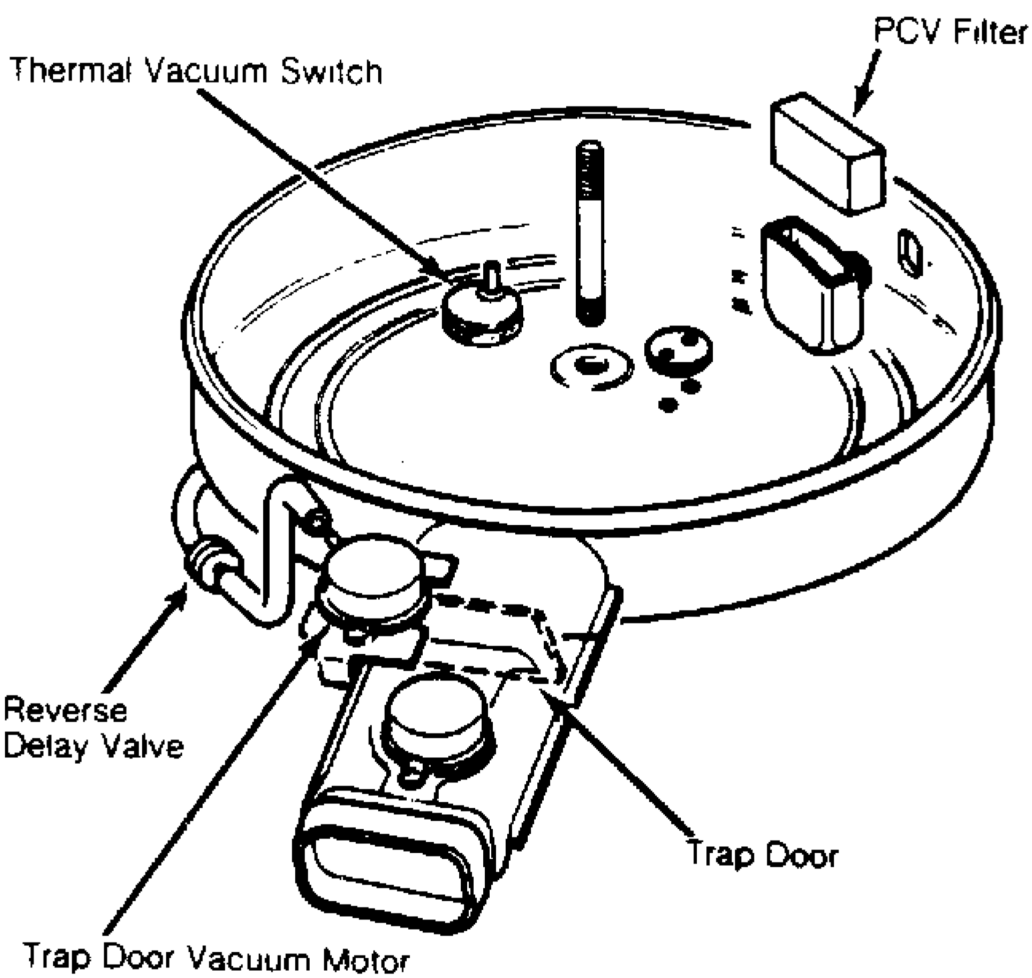


Fig. 1: Thermostatic Air Cleaner (TAC) Assembly
Courtesy of Chrysler Motors.

OPERATION

During engine warm-up, temperature sensor switch applies vacuum to vacuum motor. Air diverter valve is held to "ON" position. Exhaust manifold heated air flows to air cleaner. As temperature of incoming air increases to 90°F (32°C), temperature sensor opens vacuum line to atmosphere allowing spring pressure to push valve to "OFF" position. Air now flows from outside, through air cleaner duct to carburetor.

AIR CLEANER TRAP DOOR

On California vehicles, spring-loaded trap door is built into air cleaner to close off air cleaner when engine is shut off. Door is vacuum operated.

REVERSE DELAY VALVE

Reverse delay valve is installed in vacuum line in some vehicles to prevent trap door from closing during low engine vacuum periods. Valve provides about 9 seconds delay before allowing trap door to close.

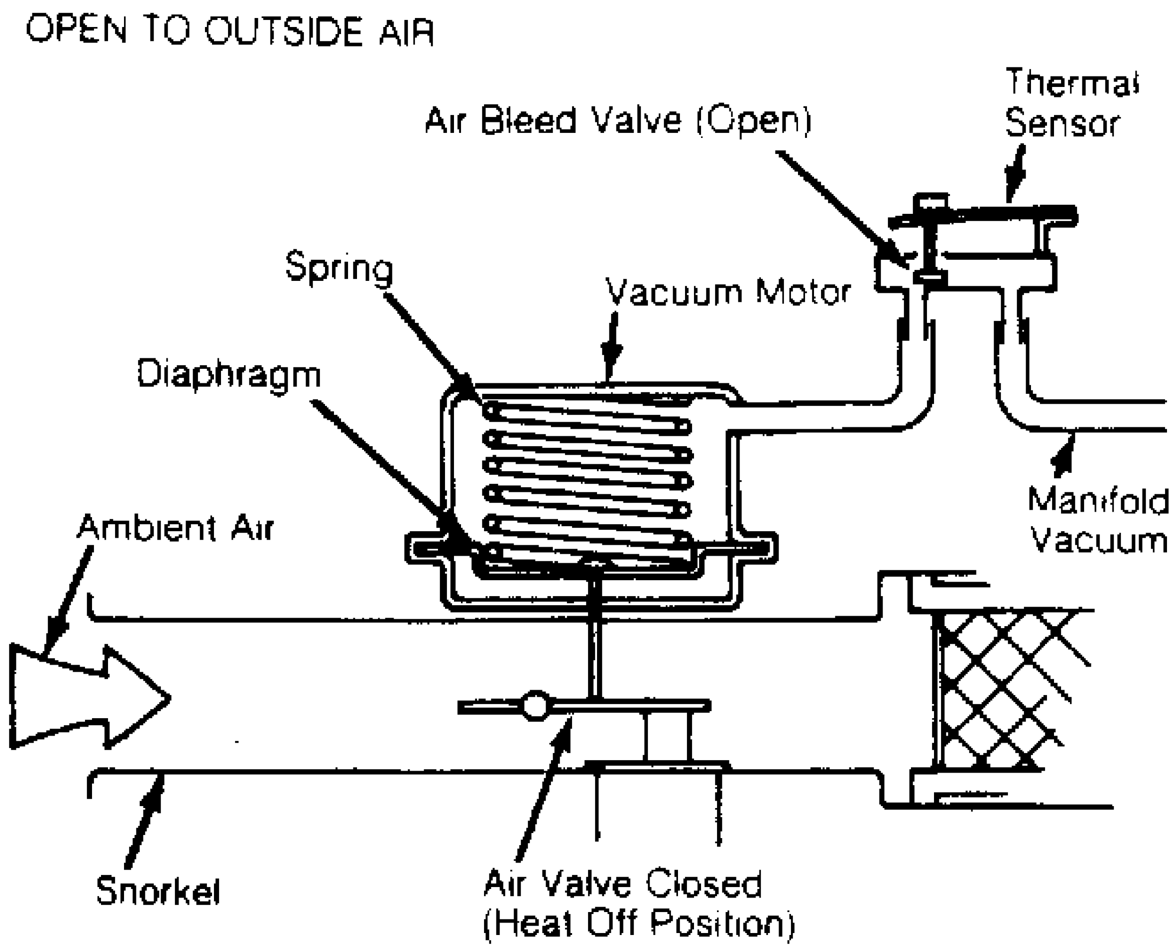


Fig. 2: Cutaway View of Thermostatic Air Cleaner Assembly
Courtesy of Chrysler Motors.

TESTING

VACUUM MOTOR & TEMPERATURE SENSOR

1) Remove air cleaner assembly from vehicle and allow to cool to room temperature. Look through air cleaner duct and observe position of air diverter valve. It should be fully open to outside air.

2) Reinstall assembly on carburetor and connect hot air duct and manifold vacuum hose. Start engine and observe position of air valve in snorkel. It should be fully closed to outside air.

3) Move throttle lever rapidly to 1/2 to 3/4 opening and release. Air diverter valve should open and then close again. Allow engine to warm to operating temperature and observe position of air valve in snorkel. It should be fully open to outside air.

4) If valve does not move to fully close off outside air at 83°F (28°C) or less with vacuum applied, check for binding of duct, vacuum leaks in hose connections or disconnected vacuum motor. If valve mechanism operates freely and no vacuum leaks are detected, connect hose from intake manifold vacuum source directly to vacuum motor.

5) If air valve now moves to close off outside air, replace thermal sensor switch. If valve still does not move to close off outside air, replace air cleaner assembly and vacuum motor assembly.

TRAP DOOR

1) With engine off, remove air cleaner and check position of trap door. It should be closed.

2) Remove vacuum hose from intake manifold vacuum source and apply an external vacuum source of approximately 2-4 in. Hg vacuum. Trap door should open.

3) If door does not open, apply vacuum directly to vacuum motor. If door does not open, check for binding and adjust as necessary. If door swings freely, replace vacuum motor.

4) If door opens during step 3), check vacuum hose for blockage, cracks or leaks. Correct as necessary and retest as specified in step 2).

5) If hoses are not defective, remove reverse delay valve, join vacuum hose and retest from step 2). If door opens, replace reverse delay valve.

REVERSE DELAY VALVE

1) Connect external vacuum source to port on White side of delay valve. Connect one end of 24" (610 mm) section of rubber hose to vacuum gauge and other end to port on colored side of valve.

2) With a constant 10 in. Hg vacuum applied, note time required for vacuum gauge pointer to move from 0-8 in. Hg.

AIR INJECTION SYSTEM

1988 Jeep Cherokee

1988 Exhaust Emission Systems
JEEP PULSE AIR INJECTION SYSTEM

4.2L

DESCRIPTION

Pulse air injection system is used to inject fresh air into exhaust system. When fresh air is injected into hot exhaust gases, combustion takes place. This reduces amount of unburned fuel that escapes into the atmosphere.

System consists of check valves, control valves, control valve solenoids, vacuum reservoir, vacuum lines and air lines. Pulse air system is capable of injecting air at both catalytic converter (downstream) or at front exhaust pipe.

OPERATION

Pulse air system uses alternating positive and negative pressure pulsations in exhaust system to draw in fresh air through air cleaner. Check valves are used to allow fresh air into exhaust, but prevent exhaust from flowing back into intake system.

Air is switched between upstream and downstream injection by 2 vacuum-operated control valves. Each control valve is switched by an electrically operated-vacuum solenoid.

Vacuum solenoids are switched on and off by MCU according to engine operating conditions. Vacuum storage tank maintains vacuum supply to switching solenoids.

DIAGNOSIS & TESTING

1) Check condition of all hoses and lines in system. Reroute any kinked or restricted hoses. Repair or replace any cracked or broken hoses. To check system operation, feel for suction in injection hoses at air cleaner.

2) If problem exists, check to see if vacuum is being supplied to the valve. If vacuum is not present at valve(s), check vacuum lines or ports.

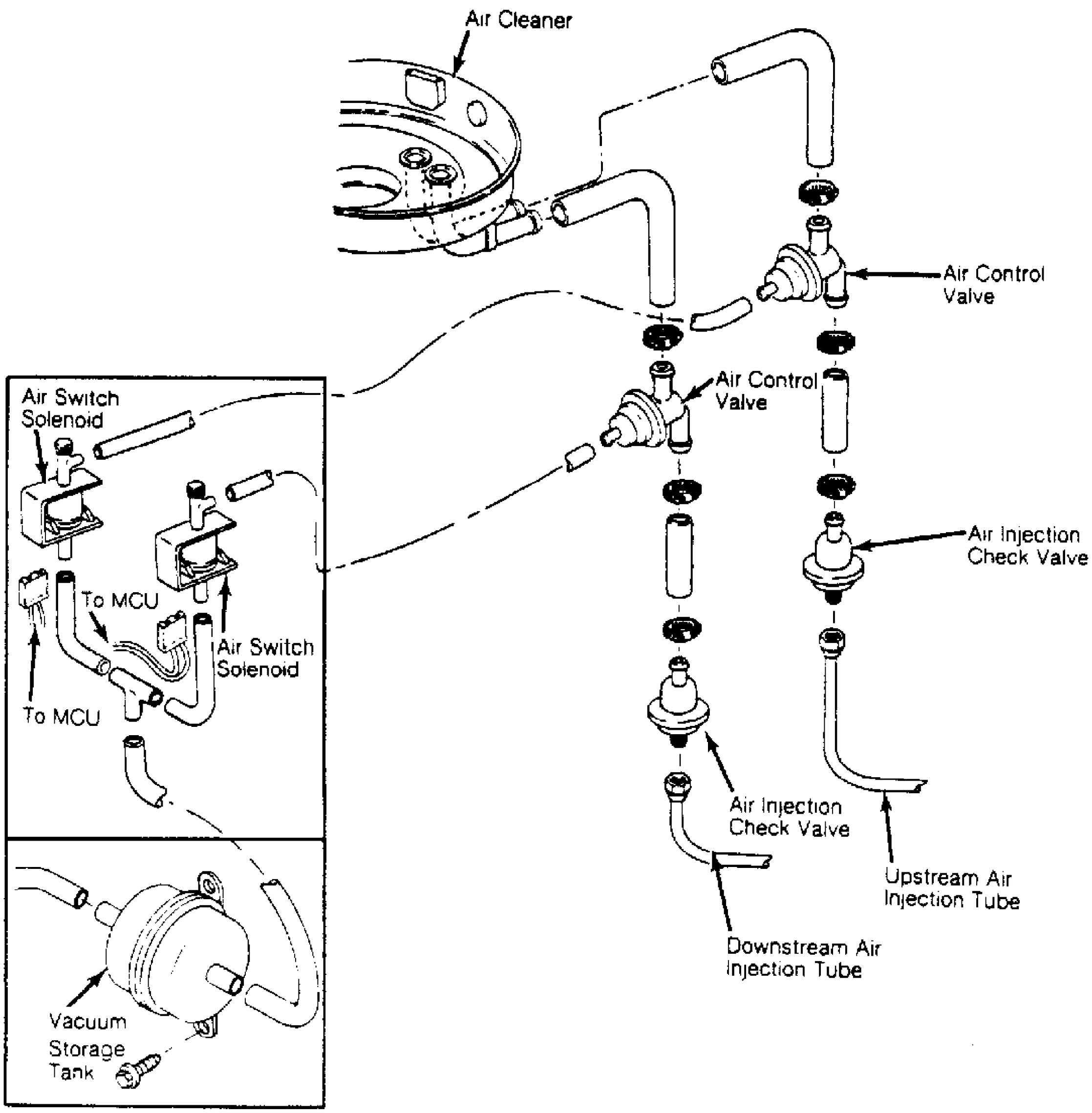


Fig. 1: Jeep Pulse Air Injection System
Courtesy of Chrysler Motors.

ALTERNATOR - DELCO W/INTEGRAL REGULATOR

1988 Jeep Cherokee

1988 Alternators & Regulators
DELCO-REMY WITH INTEGRAL REGULATOR

Jeep

DESCRIPTION

There are 2 types of alternators used on these vehicles. The 12SI and 17SI series (Systems Integral), means alternator with built-in regulator. All 12SI alternators have "Y" stator windings, while all 17SI have delta windings.

The CS130 (Charging System) alternators have a high amperage output. This alternator does not have a diode trio.

IDENTIFICATION

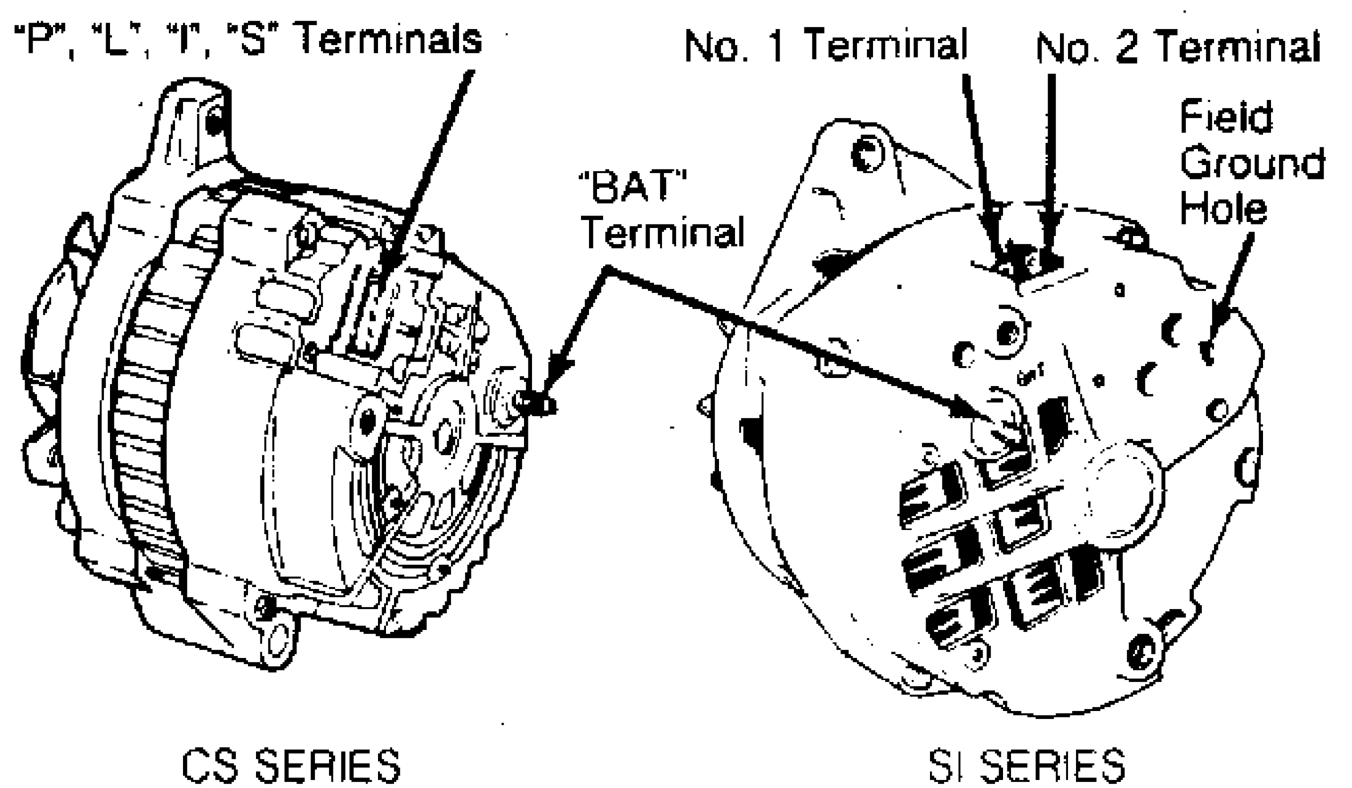


Fig. 1: Alternator Terminal Identification & Locations
"S" terminal is optional on CS130.

OPERATION

CS SERIES

Regulator voltage varies to compensate for temperature. Voltage is regulated by controlling rotor field current. Regulator switches rotor field current "on" and "off" at a fixed frequency of approximately 400 cycles per second.

By controlling "on" and "off" time correct system voltage can

be obtained. During high speeds "on" time may be 10 percent and "off" time 90 percent. During low speeds with high electrical loads, "on" time may be 90 percent and "off" time 10 percent.

SI SERIES

A rectifier bridge, connected to stator windings, contains 6 diodes (3 positive and 3 negative) molded into an assembly. This rectifier bridge changes stator AC voltage into DC voltage, which appears at output terminal.

Alternator field current is supplied through a diode trio which is also connected to stator windings. A capacitor is mounted to end frame, protecting rectifier bridge and diodes from high voltage and suppressing radio interference noise.

TROUBLE SHOOTING

NOTE: See the TROUBLE SHOOTING - BASIC PROCEDURES article in the GENERAL TROUBLE SHOOTING section.

TESTING

PRELIMINARY INFORMATION

NOTE: Before making electrical checks, visually inspect all terminals for clean, tight connections. Check alternator mounting bolts and drive belt tension. Battery must be in good condition to test charging system.

TESTING (ON-VEHICLE)

CS SERIES

Over/Undercharged Battery (W/ STandard Instruments)

1) If an overcharging condition is suspected, run engine at a moderate speed. Connect a voltmeter across battery terminals. If voltmeter indicates more than 16 volts, replace alternator.

2) If an undercharging condition is suspected, disconnect 2—wire connector from alternator. Turn ignition on with engine off. Connect a voltmeter between terminal "L" in wiring harness and ground. Record reading.

3) If terminal "I" is used, connect voltmeter between terminal "I" and ground. Record reading. If voltmeter reads battery voltage, circuits are okay. If voltmeter reads zero, this indicates an open circuit between terminal checked and battery. Repair as necessary.

Overcharged Battery (W/ Gauges)

If an overcharging condition is suspected, run engine at a moderate speed. Connect a voltmeter across battery terminals. If voltmeter indicates more than 16 volts, replace alternator.

Alternator Output Test (W/ Standard Instruments Or Gauges)

1) Run engine at moderate speed, all electrical accessories off. Measure voltage across battery, if above 16 volts, replace alternator.

2) Connect an ammeter in circuit at "BAT" terminal of alternator. Turn on all available accessories. Connect a battery load tester across battery. Operate engine at 2000 RPM and adjust battery load tester as required to obtain maximum current output while

maintaining 13 volts or more.

3) Output must be within 15 amps of rated output stamped on alternator. If output is not within 15 amps of rated output, replace alternator.

SI SERIES

Overcharged Or Undercharged Battery

1) If an overcharging condition is suspected, attach a voltmeter across battery terminals. Run engine at a moderate speed with all accessories off. If voltmeter reads 15.5 volts or more, remove alternator for repair.

2) If an undercharging condition is suspected, turn ignition on. Connect a voltmeter from alternator "BAT" terminal to ground. Voltmeter should read 12 volts. Connect voltmeter between No. 1 terminal and ground. Voltmeter should read one volt or more.

3) Connect voltmeter between No. 2 terminal and ground. Voltmeter should read 12 volts. A zero reading on any connection indicates an open between connection and battery. Opens in the No. 2 lead may be between terminals at the crimp between harness wire and terminal, or in wire.

Alternator Output Test

1) Connect an ammeter in circuit at "BAT" terminal of alternator. Turn on all available accessories. Connect a carbon pile across battery. Operate engine at 2000 RPM and adjust carbon pile as required to obtain maximum current output.

2) Ampere output must be within 10 amps of rated output. If output is not within 10 amps of rated output, ground field winding by inserting a screwdriver into test hole. Repeat step 1).

3) If output is increases to within 10 amps of rated output with field grounded, regulator is defective. If output remains below 10 amps of rated output, check field winding, diode trio, rectifier bridge, and stator.

CAUTION: Tab is within 3/4" of casting surface. DO NOT force tool beyond 1" into end frame. If test hole is not accessible, proceed to BENCH TESTING.

BENCH TESTING

NOTE: There are no internal checks for CS series alternators.

SI SERIES

Rotor Field Winding Test

1) To check for grounds, attach ohmmeter leads to shaft and slip ring (each ring in turn). If reading is not infinity, replace rotor.

2) To test for open field, attach ohmmeter leads to each slip ring. Resistance should measure about 2.4—2.8 ohms on 12SI series, or 1.7—2.1 ohms on 17SI series. If not, replace rotor.

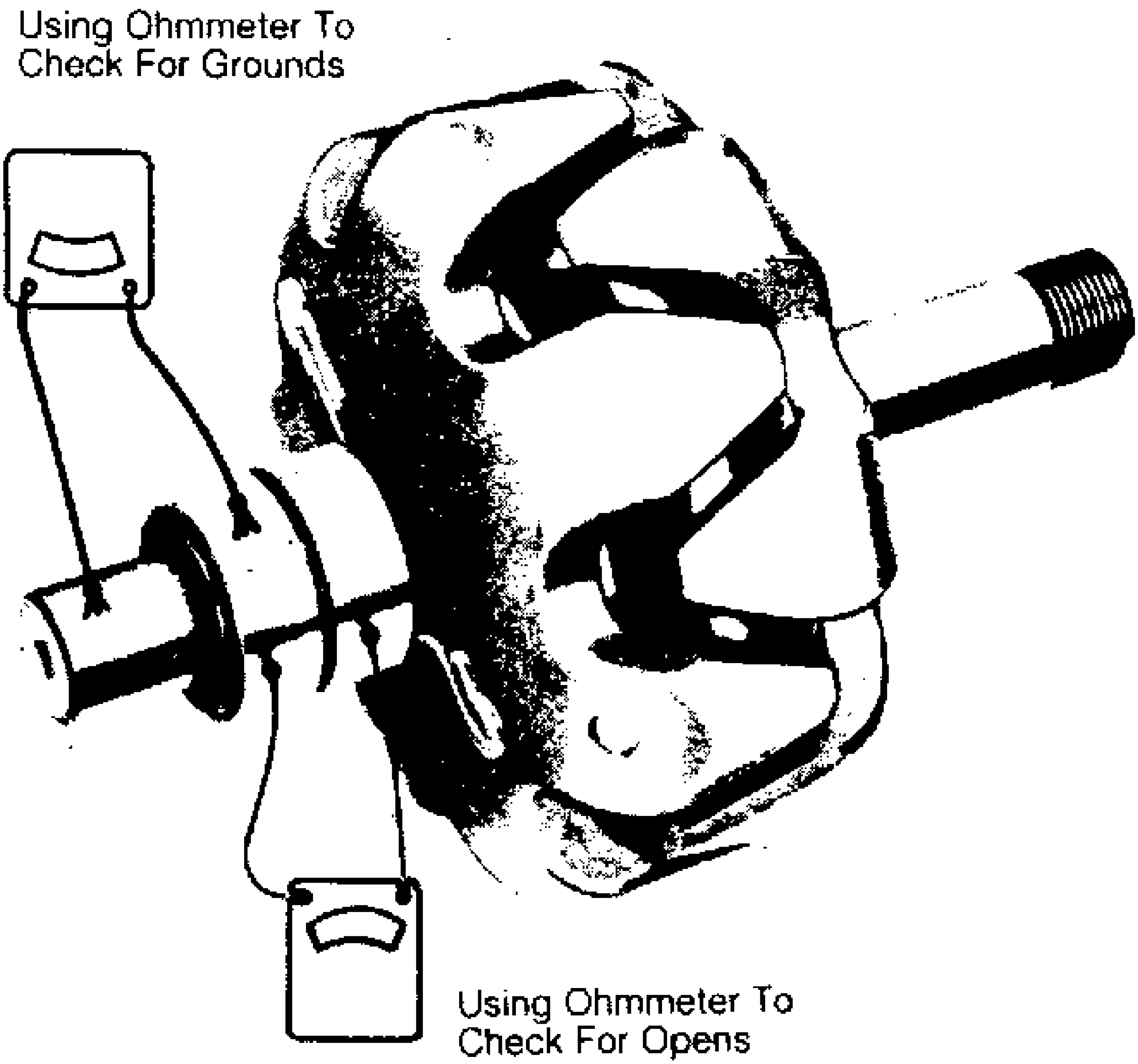


Fig. 2: Rotor Bench Test For Open or Short Circuit

Stator Test

NOTE: Delco 17SI alternator has delta stator windings and cannot be checked for open circuit.

1) For 12SI series alternator, measure resistance between stator leads. See Fig. 3. If reading is not infinity, replace stator.

2) On all models, connect ohmmeter leads to any stator lead and to stator frame. Ohmmeter reading should be infinity. See Fig. 3.

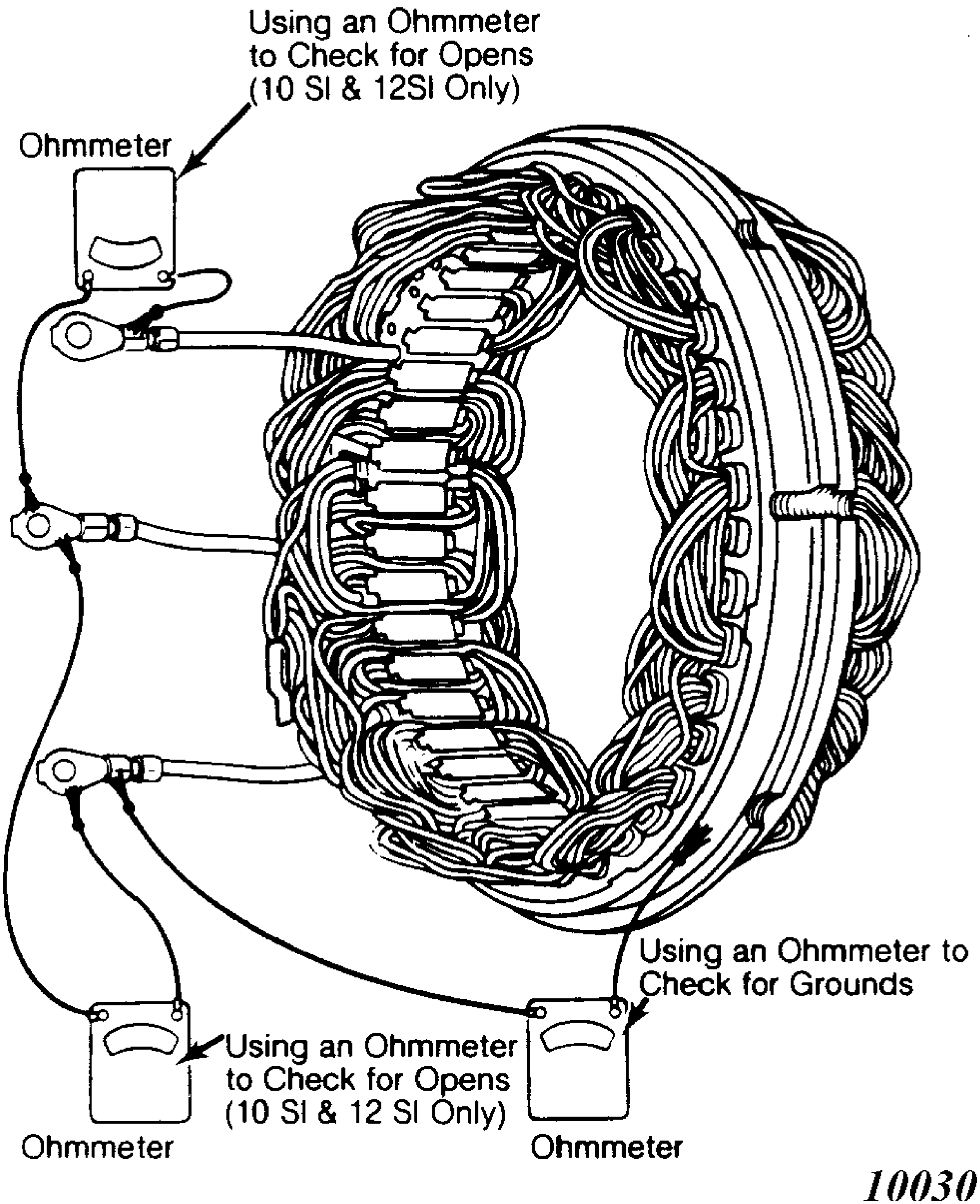


Fig. 3: Testing Stator for Open or Grounded Circuits

Diode Trio Test

1) Remove diode trio from end frame. Connect an ohmmeter to single connector and to one of the 3 connectors. See Fig. 4. Note

reading and reverse leads. If readings are the same, replace diode trio.

2) A good diode trio will give a high and low reading. Repeat tests between single connector and each of the 3 connectors. Connect ohmmeter to each of the 3 connectors. If any readings are zero, replace diode trio.

NOTE: Before replacing diode trio, also check rectifier bridge. DO NOT use high voltage, such as 110—volt test light, when testing diode trio.

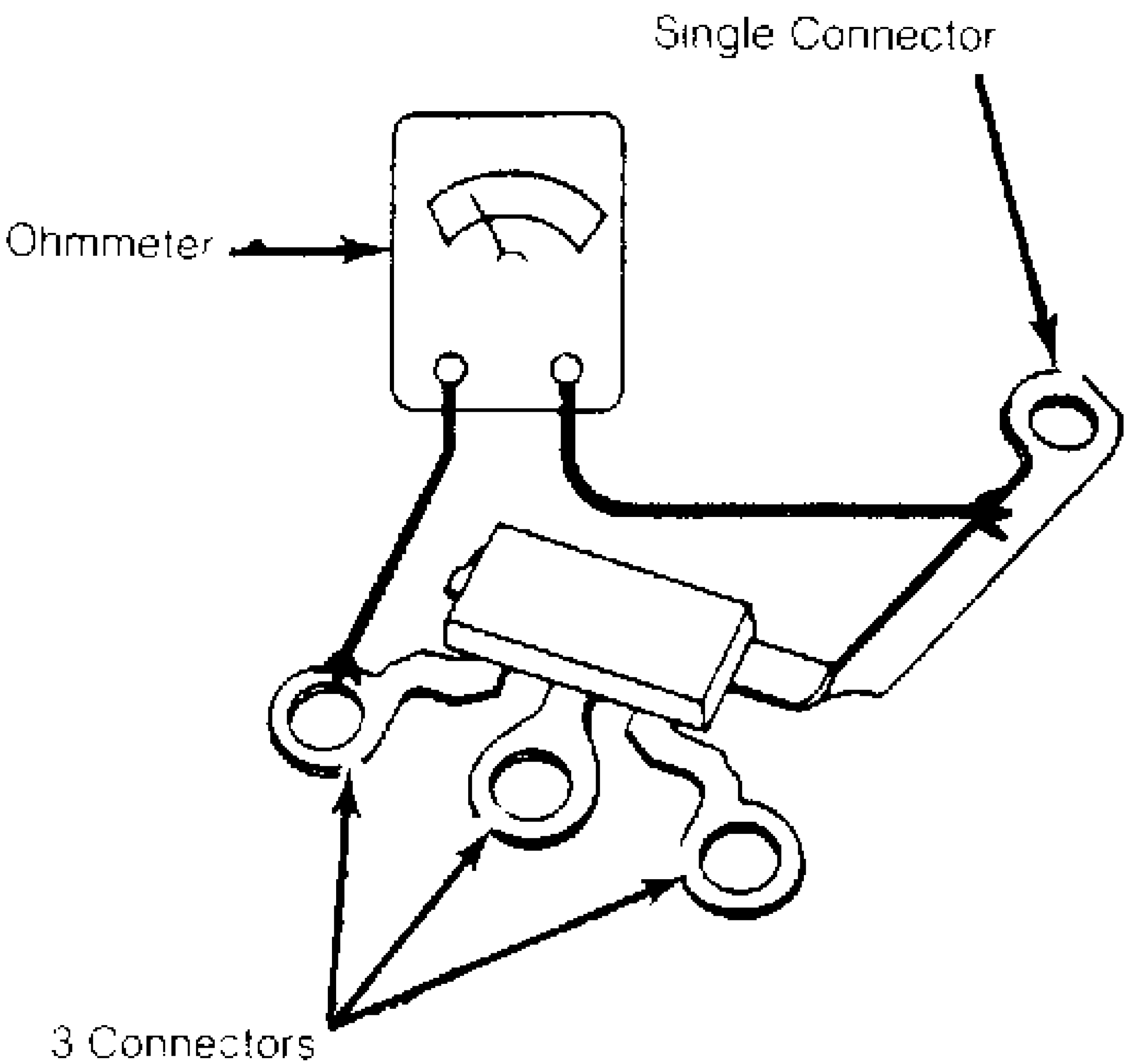


Fig. 4: Bench Testing Diode Trio

Rectifier Bridge Test

1) Position ohmmeter with one lead touching grounded heat sink and the other lead touching flat metal on one of the 3 terminals

or threaded studs. Observe reading and reverse test lead connections. See Fig. 5.

2) If both readings are the same, replace rectifier bridge. A good bridge will give a high and low reading. Retest all terminals (6 tests with insulated heat sink).

3) Connect test leads to insulated heat sink and one edge of the 3 terminals. Observe reading and reverse connections. Repeat test on all terminals (6 tests with insulated heat sink).

4) When all 12 tests have been made, testing is complete. DO NOT use high voltage light to check bridge. DO NOT replace diode trio or rectifier bridge unless at least one pair of readings is the same (with leads reversed).

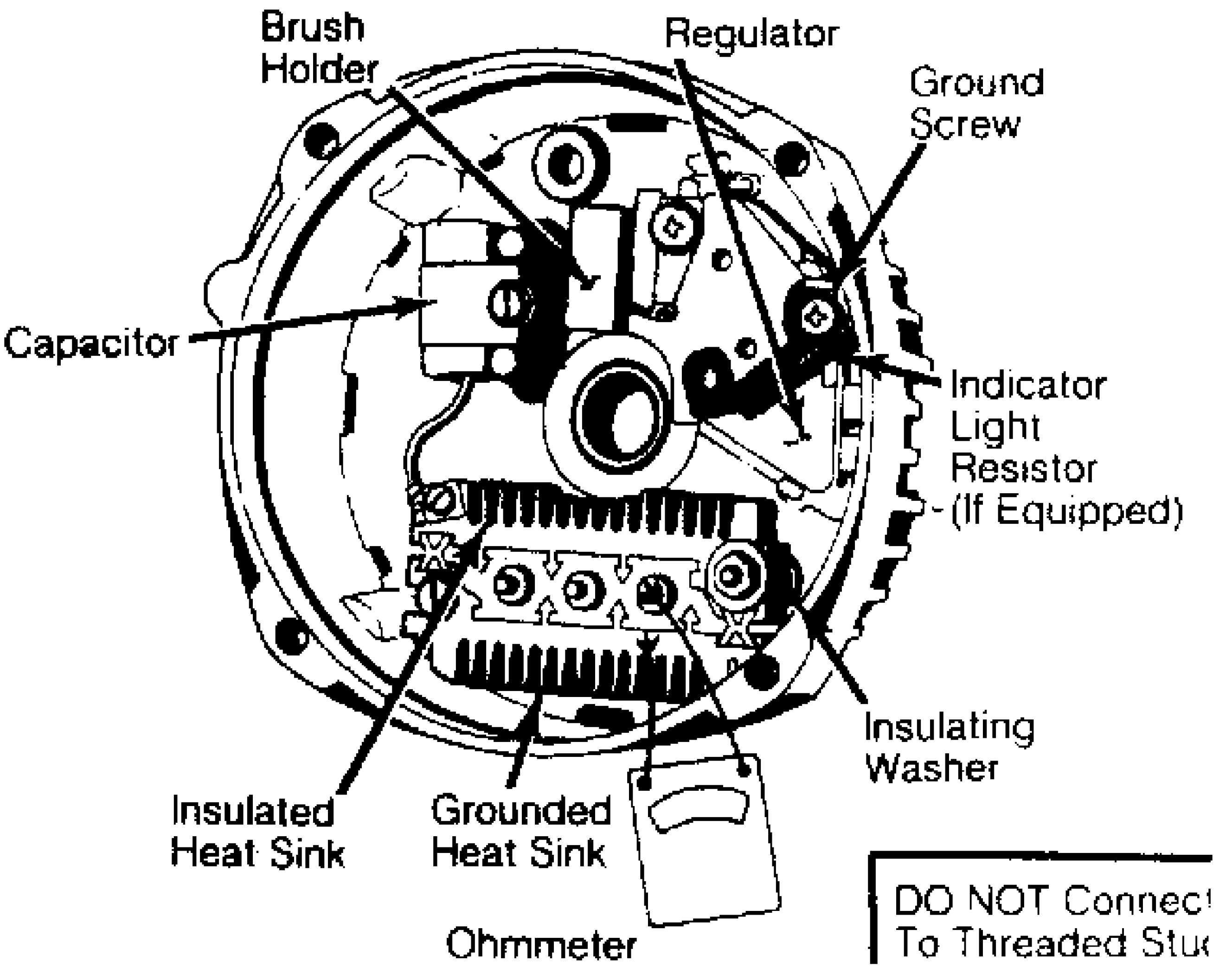


Fig. 5: Bench Testing Rectifier Bridge

OVERHAUL

NOTE: There are no overhaul procedures for CS130 alternators.

INSPECTION

Wash all metal parts except bearings, stator and rotor. Inspect rotor slip rings. They may be cleaned with 400 grit or finer

polishing cloth, while rotor is being rotated. Slip rings may be lathe turned to .002" (.05 mm) maximum indicator reading.

Slip rings are not replaceable. Excessive damage will require rotor replacement. Inspect brushes for wear, replacing them if more than 50% worn.

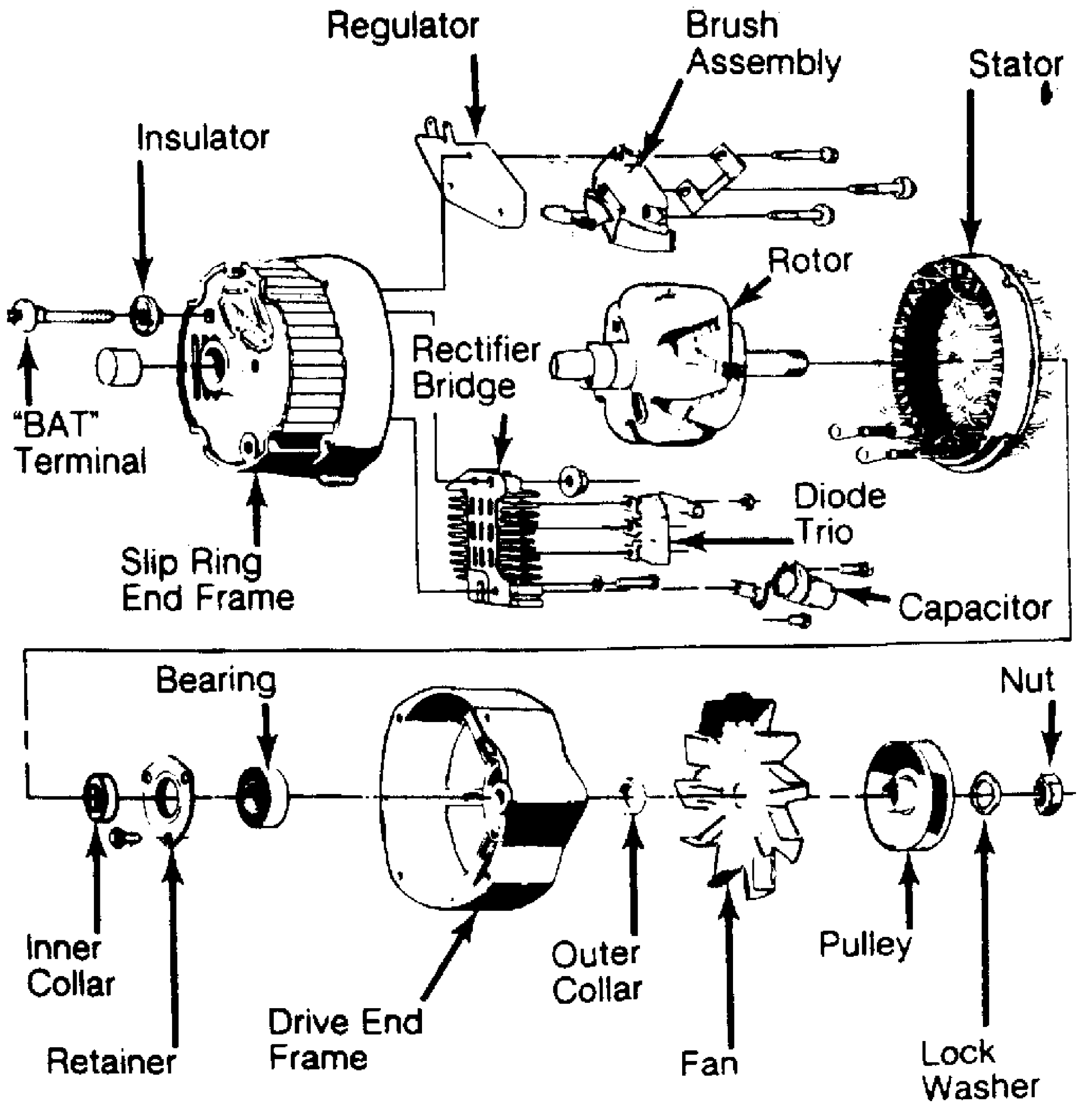


Fig. 6: Exploded View of Model 12SI Alternator
Courtesy of General Motors Corp.

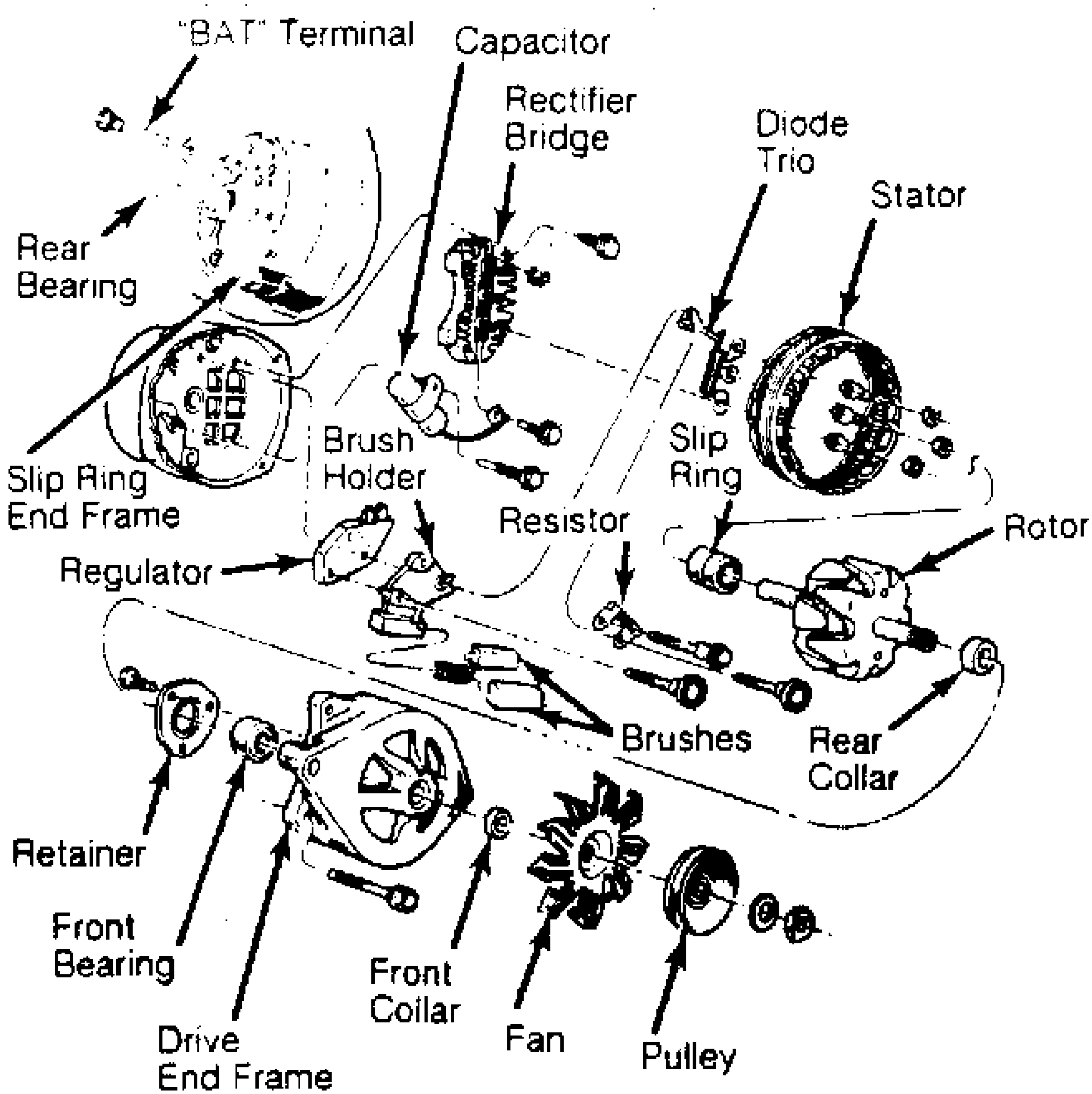


Fig. 7: Exploded View of Model 17SI Alternator
Courtesy of General Motors Corp.

SPECIFICATIONS

ALTERNATOR OUTPUT FOR CS SERIES

Stamped Rating	Amps @ 14v	Engine RPM
85	30	1600
100	36	1600
105	42	1600

ALTERNATOR OUTPUT FOR SI SERIES

Stamped Rating	Amps @ 14v	Engine RPM
66	23	1600
78	30	1600
94	30	1600
120	50	1600

ANTI-LOCK BRAKE SAFETY PRECAUTIONS

1988 Jeep Cherokee

GENERAL INFORMATION
Anti-Lock Brake Safety Precautions

* PLEASE READ THIS FIRST *

This article is intended for general information purposes only. This information may not apply to all makes and models. If vehicle is equipped with Anti-Lock Brake System (ABS), refer to appropriate ANTI-LOCK BRAKE SYSTEM article in the BRAKES section for description, operation, depressurizing, testing, system bleeding, trouble shooting and servicing of specific system.

WARNING: Failure to depressurize ABS could lead to physical injury.

ANTI-LOCK BRAKE SAFETY PRECAUTIONS

WARNING: Failure to depressurize ABS could lead to physical injury.

* NEVER open a bleeder valve or loosen a hydraulic line while ABS is pressurized.
* NEVER disconnect or reconnect any electrical connectors while ignition is on. Damage to ABS control unit may result.
* DO NOT attempt to bleed hyudarulic system without first referring to the appropriate ANTI-LOCK BRAKE SYSTEM article in the BRAKES section.
* Only use specially designed brake hoses/lines on ABS equipped vehicles.
* DO NOT tap on speed sensor components (sensor, sensor rings). Sensor rings must be pressed into hubs, NOT hammered into hubs. Striking these components can cause demagnetization or a loss of polarization, affecting the accuracy of the speed signal returning to the ABS control unit.
* DO NOT mix tire sizes. Increasing the width, as long as tires remain close to the original diameter, is acceptable. Rolling diameter must be identical for all 4 tires. Some manufacturers recommend tires of the same brand, style and type. Failure to follow this precaution may cause inaccurate wheel speed readings.
* DO NOT contaminate speed sensor components with grease. Only use recommended coating, when system calls for an anti-corrosion coating.
* When speed sensor components have been removed, ALWAYS check sensor-to-ring air gaps when applicable. These specifications can be found in each appropriate article.
* ONLY use rocommended brake fluids. DO NOT use silicone brake fluids in an ABS equipped vehicle.
* When instlling transmittion devices (CB's, telephones, etc.) on ABS equipped vehicles, DO NOT locate the antenna near the ABS control unit (or any control unit).
* Disconnect all on-board computers, when using electric welding equipment.
* DO NOT expose the ABS control unit to prolonged periods of high heat (185 °F/85°C for 2 hours is generally considered a maximum limit).

AUTO TRANS DIAGNOSIS - AW4

1988 Jeep Cherokee

AUTOMATIC TRANSMISSIONS
Aisin Warner 4 Electronic Diagnosis

APPLICATION

NOTE: Transmission may also be referred to as AW-4.

TRANSMISSION APPLICATION

Vehicle Application	Transmission Model
Jeep	
1987-96 Cherokee	AW4
1987-92 Comanche	AW4
1987 Grand Wagoneer	AW4
1987-90 Wagoneer	AW4
1992 Wrangler	AW4

NOTE: Vehicle body code may be required when diagnosing or repairing transmission, as body code may be used instead of vehicle model name. See BODY CODE DESIGNATION table.

BODY CODE DESIGNATION

Vehicle Model	Body Code
Cherokee	XJ
Comanche	MJ
Grand Wagoneer	SJ
Wagoneer	XJ
Wrangler	YJ

DESCRIPTION

The electronic control system for the AW-4 transmission controls transmission shift points and torque converter lock-up. Electronic control system consists of Transmission Control Module (TCM), valve body solenoids, throttle position sensor, speed sensor, neutral safety switch and brake switch.

NOTE: Transmission Control Module (TCM) may be referred to as Transmission Control Unit (TCU). Neutral safety switch may be referred to as park/neutral safety switch or gear select switch.

OPERATION

TRANSMISSION CONTROL MODULE (TCM)

The TCM determines shift points and torque converter lock-up based on input signals received from throttle position sensor, neutral safety switch, speed sensor and brake switch. The TCM controls transmission shift points and torque converter lock-up by operating electric solenoids mounted on the valve body.

The TCM contains a self-diagnostic system used for determining an electronic component failure. The TCM self-diagnostic

system will store a diagnostic trouble code in the TCM memory if certain electronic problems exist. If electronic problem goes away, diagnostic trouble code will be erased from TCM memory after ignition has been cycled approximately 75 times.

NOTE: Diagnostic trouble code may be referred to as fault code.

Diagnostic trouble codes can be retrieved using a Diagnostic Readout Box-II (DRB-II). After repairing an electrical system problem, stored diagnostic trouble code must be cleared from TCM memory.

The TCM is located behind right side of instrument panel on Cherokee. See Fig. 1.

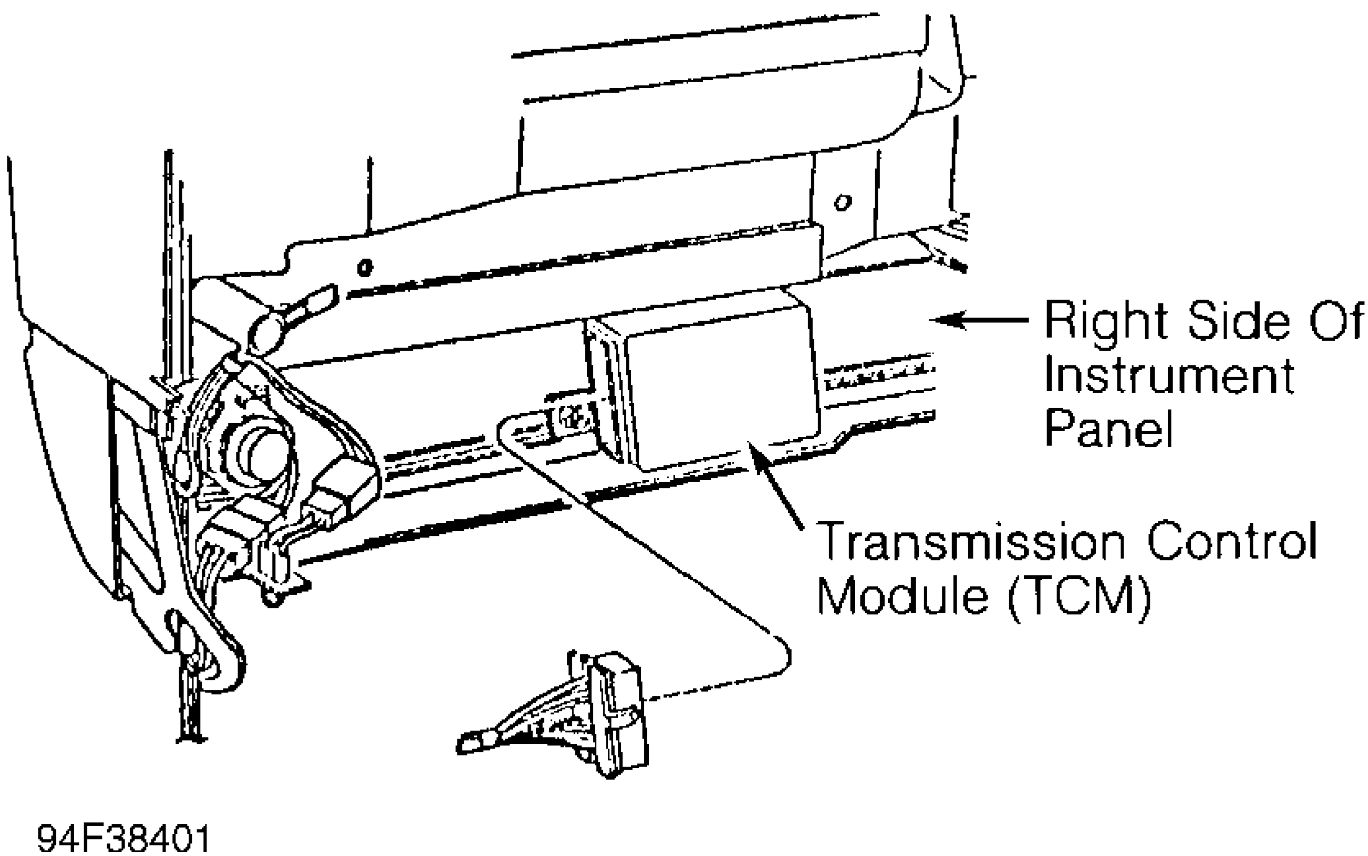


Fig. 1: Transmission Control Module (TCM) I.D. (Cherokee)
Courtesy of Chrysler Corp.

VALVE BODY SOLENOIDS

Valve body solenoids, mounted on the valve body, are output devices controlled by signals received from the TCM. See Fig. 2. The No. 1 and 2 valve body solenoids control transmission shifts while the No. 3 valve body solenoid is used for torque converter lock-up.

When No. 1 and 2 valve body solenoids are energized, solenoid plunger moves from seat. This opens the drain port and releases line pressure. When either valve body solenoid is de-energized, plunger closes the drain port.

The No. 3 valve body solenoid operates in reverse. When No. 3 valve body solenoid is de-energized, solenoid plunger moves away from seat. This opens the drain port and releases line pressure. When No. 3 valve body solenoid is energized, the plunger closes the drain port.

NOTE: For valve body solenoid usage, see VALVE BODY SOLENOID APPLICATION table.

VALVE BODY SOLENOID APPLICATION (1)

Shift Lever Position	No. 1 Solenoid	No. 2 Solenoid
"D" (Drive)		
1st Gear	ON	OFF
2nd Gear	ON	ON
3rd Gear	OFF	ON
4th Gear	OFF	OFF
"3"		
1st Gear	ON	OFF
2nd Gear	ON	ON
3rd Gear	OFF	ON
"1-2"		
1st Gear	ON	OFF
2nd Gear	ON	ON
"R" (Reverse)	ON	OFF
"N" Or "P"	ON	OFF

(1) - Valve body contains 3 valve body solenoids. See Fig. 2. No. 1 and 2 valve body solenoids are used for controlling transmission shifts. No. 3 valve body solenoid is used for torque converter lock-up only.

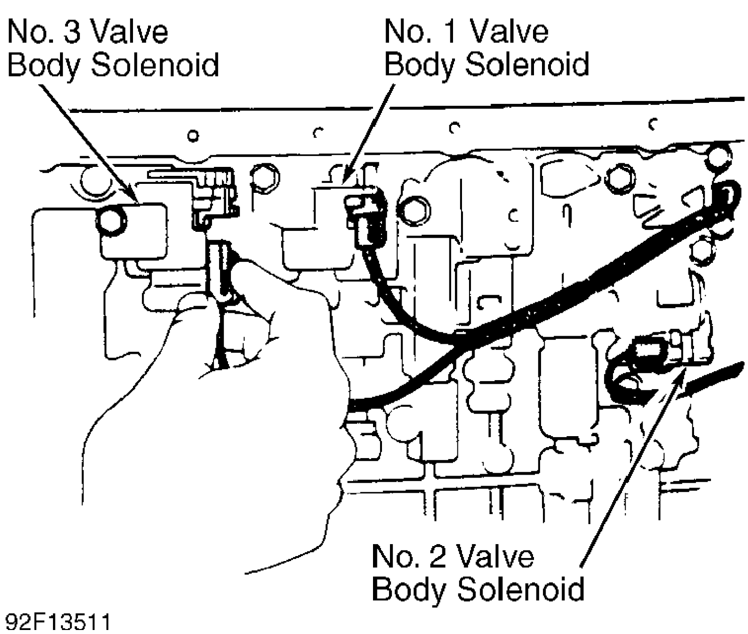


Fig. 2: Identifying Valve Body Solenoids
Courtesy of Chrysler Corp.

BRAKE SWITCH

Brake switch is an input device mounted above the brake pedal. When brake pedal is operated, brake switch delivers an input signal to the TCM. The TCM uses input signal for controlling No. 3 valve body solenoid for torque converter lock-up.

NEUTRAL SAFETY SWITCH

NOTE: Neutral safety switch may be referred to as park/neutral safety switch or gear select switch.

Neutral safety switch is an input device mounted on the transmission manual valve shaft. Neutral safety switch delivers an input signal to TCM, indicating transmission manual valve gear position.

SPEED SENSOR

Speed sensor, mounted in adapter housing or extension housing, is an input device consisting of speed sensor rotor and speed sensor. Speed sensor rotor is mounted on transmission output shaft. Input signal is delivered from speed sensor to TCM with each revolution of transmission output shaft. The TCM uses input signal for controlling transmission operation.

THROTTLE POSITION SENSOR (TPS)

The TPS, mounted on throttle body, determines throttle position and delivers an input signal to TCM. The TCM uses input signal for controlling transmission upshifts and torque converter lock-up.

SELF-DIAGNOSTIC SYSTEM

DIAGNOSTIC PROCEDURE

When performing vehicle diagnosis:

* Ensure transmission fluid level is correct and fluid is neither contaminated nor aerated.
* Ensure shift cable is properly adjusted. Refer to the appropriate TRANSMISSION SERVICING - A/T article in this section.
* Ensure battery is fully charged.
* Perform visual inspection, ensuring all electrical connections at transmission, TCM, throttle position sensor, neutral safety switch, speed sensor and brake switch are clean and properly installed.
* Perform TEST 1A - VERIFICATION OF THE COMPLAINT under TROUBLE SHOOTING CHARTS in this article.
* Repair diagnostic trouble codes in order displayed.
* Always perform TEST 2A - VERIFICATION TEST after repair is completed. See TEST 2A - VERIFICATION TEST under TROUBLE SHOOTING CHARTS in this article.

RETRIEVING DIAGNOSTIC TROUBLE CODES

NOTE: Manufacturer recommends using Chrysler's Diagnostic Readout Box-II (DRB-II) with proper cartridge for system diagnosis. Other after-market scan tools may be used for system diagnosis. The following procedure is for DRB-II scan tool usage. Use manufacturer's instruction for operating the

DRB-II scan tool. When retrieving diagnostic trouble codes using DRB-II, you must first enter AW4 MENU and then retrieve diagnostic trouble codes.

NOTE: Ensure TEST 1A - VERIFICATION OF THE COMPLAINT is performed when trouble shooting the vehicle. This test checks for diagnostic trouble codes with vehicle stationary and during road test. See TEST 1A - VERIFICATION OF THE COMPLAINT under TROUBLE SHOOTING CHARTS.

NOTE: The DRB-II scan tool can be used in several different modes using manufacturer's instructions to activate system components and perform several tests on transmission. See DRB-II OPERATING MODES.

Entering AW4 MENU

1) Ensure ignition is off. Connect DRB-II to 6-pin transmission diagnostic connector. See Fig. 3. Transmission diagnostic connector is located to the right of the steering column on driver's side of instrument panel above accelerator pedal or below glove box on passenger's side.

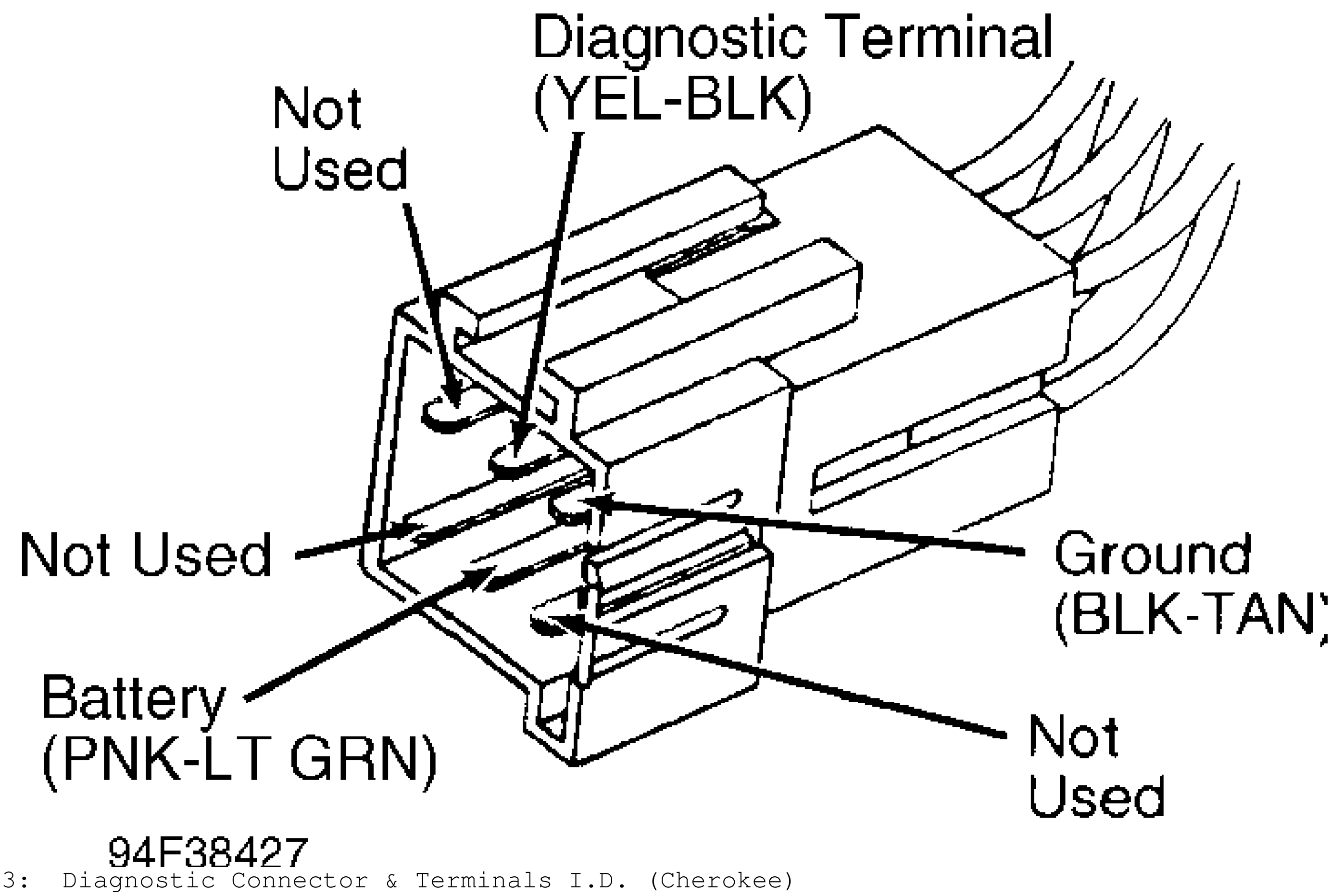


Fig. 3: Diagnostic Connector & Terminals I.D. (Cherokee)
Courtesy of Chrysler Corp.

2) Turn ignition on. Copyright date and diagnostic program will be briefly displayed. If DRB-II displays an error message, proceed to DRB-II PROBLEMS & ERROR MESSAGES. The following are possible error messages that may appear.

* CARTRIDGE ERROR
* HIGH BATTERY
* KEYPAD TEST FAILURE
* LOW BATTERY
* RAM TEST FAILURE

3) If no error messages appear, display will read as follows after a few seconds: 1) VEHICLES TESTED, 2) HOW TO USE, 3) CONFIGURE and 4) SELECT SYSTEM.

4) Select 4) SELECT SYSTEM to enter diagnostic system. Once in SELECT SYSTEM, select 2) TRANSMISSION to enter transmission. Display will read 1) EATX and 2) AW4.

5) Select 2) AW4. After a few seconds display will change to read AW4, VERSION 01. After a few seconds, display will read AW4 MENU, 1) SYSTEM TEST and 2) READ FAULTS. If DOWN ARROW is depressed 3 times, display will read as follows: 3) STATE DISPLAY, 4) ACTUATOR TESTS and 5) ADJUSTMENTS.

NOTE: The ACTUATOR TESTS and ADJUSTMENTS cannot be used when diagnosing the AW-4 transmission.

Retrieving Diagnostic Trouble Codes

1) Select 2) READ FAULTS from AW4 MENU. If no diagnostic trouble code exists, display will read as follows: AW4 FAULTS, NO FAULTS DETECTED.

2) If diagnostic trouble code exists, the following message will be displayed: 1 OF 3 FAULTS. This number will vary depending on number of diagnostic trouble codes stored in the TCM memory.

3) Diagnostic trouble code and message will be displayed. Press DOWN ARROW key to display next diagnostic trouble code. To identify diagnostic trouble code, see DIAGNOSTIC TROUBLE CODE IDENTIFICATION table.

NOTE: See TROUBLE SHOOTING CHARTS to diagnose faults indicated by trouble codes.

NOTE: Valve body solenoid diagnostic trouble code 700 may appear in a FAULT PRESENT or FAULT STORED status. Status will be displayed along with diagnostic trouble code. Diagnostic trouble code must be diagnosed depending on the status. See TEST 1A - VERIFICATION OF THE COMPLAINT under TROUBLE SHOOTING CHARTS.

DIAGNOSTIC TROUBLE CODE IDENTIFICATION

Trouble Code	Problem Area
700 (1)	Valve Body Solenoid
702	Speed Sensor
703	(2) Gear Select Switch
705	Throttle Position Sensor
706	Brake Switch
707	Wrong TCM Or TCU

(1) - Trouble code may apply to individual valve body solenoids. Valve body solenoid may be referred to as S1 for No. 1, S2 for No. 2 and S3 for No. 3.
(2) - Gear select switch is the same as the neutral safety switch.

CLEARING DIAGNOSTIC TROUBLE CODES

1) Once all diagnostic trouble codes have been obtained, diagnostic trouble code(s) can be erased from TCM memory by disconnecting electrical connector from TCM for at least 15 seconds.

CAUTION: DO NOT disconnect battery, as data stored in other vehicle control modules will be lost.

2) The TCM is located behind right side of instrument panel on Cherokee. See Fig. 1.

DRB-II OPERATING MODES

NOTE: The DRB-II can be operated in several different modes to perform various tests. Except for voltmeter/ohmmeter and HOW TO USE modes, all other operating modes are selected from AW4 MENU. See ENTERING AW4 MENU under RETRIEVING DIAGNOSTIC TROUBLE CODES.

VOLTMETER/OHMMETER MODE

To access voltmeter/ohmmeter mode, connect Red volt-ohmmeter test lead to Red port at top right corner of DRB-II. There are 2 different ports on top of DRB-II; ensure test lead is connected to proper port. Access voltmeter or ohmmeter mode using manufacturer's instructions.

NOTE: The DRB-II is grounded through transmission diagnostic connector and only one test lead is required. When diagnosing transmission, an external volt-ohmmeter may sometimes be required.

HOW TO USE MODE

1) This mode gives instructions on DRB-II usage. To enter this mode, see steps 1) through 4) of ENTERING AW4 MENU under RETRIEVING DIAGNOSTIC TROUBLE CODES. Select 2) HOW TO USE.

2) A series of screens will be displayed explaining DRB-II key usage for system diagnosing.

SYSTEM TEST MODE

NOTE: SYSTEM TEST mode consists of a stationary test and a road test. The SYSTEM TEST mode must be selected from AW4 MENU. See ENTERING AW4 MENU under RETRIEVING DIAGNOSTIC TROUBLE CODES.

1) Stationary test monitors transmission system data, current valve body solenoid failures, switch failures, correct TCM application, calibration and operation. Road test checks all valve body solenoids and speed sensor.

2) Technician will be instructed to place shift lever in each gear position, starting by shifting into 1-2 position. Once transmission is in Park, brake pedal must be depressed to check brake switch.

3) After brake switch is checked, technician will be instructed to slowly depress throttle. DRB-II will display 7 asterisks (*******) corresponding to throttle position. While depressing accelerator, Throttle Position Sensor (TPS) sweeps through entire range of positions required by the TCM.

4) A corresponding asterisk will be cleared from DRB-II display as each throttle position is sensed by TCM. Several attempts may be required to clear all asterisks from the display, depending on

how fast accelerator is depressed.

5) After throttle position is checked, technician will be instructed to drive the vehicle. The DRB-II will indicate if a requested action is seen by the TCM. If technician is requested to perform a particular operation and TCM does not acknowledge the action, press ENTER key to continue testing.

6) The TCM will instruct technician to accelerate vehicle at light throttle to ensure transmission shifts through all gears, indicating proper valve body solenoid operation.

7) During road test, ensure vehicle can be accelerated slowly and evenly to allow transmission to enter all gear ranges without downshifting or braking. If a failure is sensed, a diagnostic trouble code will be displayed on DRB-II.

NOTE: If TCM senses a failure, control logic activates a specified valve body solenoid to obtain a certain gear depending on failure. Because transmission diagnostic trouble codes are displayed one at a time, multiple diagnostic trouble codes must be identified by retesting transmission.

STATE DISPLAY MODE

NOTE: STATE DISPLAY mode must be selected from AW4 MENU. See ENTERING AW4 MENU under RETRIEVING DIAGNOSTIC TROUBLE CODES. Select 3) STATE DISPLAY on DRB-II.

Module Information

When selecting module information option, the TCM version will be indicated by a 2-digit number. Information can be used to verify proper TCM application.

Sensor

1) When selecting sensor option, TPS and RPM indications will be shown. The TPS indicator will display a 7 segment bar graph, indicating TPS position and throttle plate angle.

2) A properly operating TPS should indicate 7 segments through full throttle travel. The RPM indicator will display transmission output shaft revolutions per minute.

Brake Switch Or Input/Output

Display indicates brake switch status, indicating whether brake pedal is applied or released. Display also indicates shift lever position, whether a valve body solenoid is on or off and present transmission operating gear.

DRB-II PROBLEMS & ERROR MESSAGES

CARTRIDGE ERROR

1) If CARTRIDGE ERROR message is displayed, disconnect DRB-II from transmission diagnostic connector. DO NOT touch keys on DRB-II keypad. Reconnect DRB-II to transmission diagnostic connector and note display.

2) If CARTRIDGE ERROR message is displayed, replace DRB-II cartridge and proceed with diagnostics. If KEYPAD TEST FAILURE message is displayed, replace DRB-II and proceed with diagnostics.

HIGH BATTERY

If HIGH BATTERY message is displayed, use external voltmeter to check battery voltage at battery terminals. If battery voltage is 11.7-13.0 volts, replace DRB-II. If battery voltage is not 11.7-13.0

volts, check charging system.

KEYPAD TEST FAILURE

1) If KEYPAD TEST FAILURE message is displayed, disconnect DRB-II from transmission diagnostic connector. DO NOT touch keys on DRB-II keypad. Reconnect DRB-II to transmission diagnostic connector and note display.

2) If KEYPAD TEST FAILURE message is not displayed, proceed with diagnostics. If KEYPAD TEST FAILURE message is displayed, replace DRB-II and proceed with diagnostics.

LOW BATTERY

If LOW BATTERY message is displayed, use external voltmeter to check battery voltage at battery terminals. If battery voltage is 11.7-13.0 volts, replace DRB-II. If battery voltage is not 11.7-13.0 volts, check charging system.

RAM TEST FAILURE

1) If RAM TEST FAILURE message is displayed, disconnect DRB-II from transmission diagnostic connector. DO NOT touch keys on DRB-II keypad. Reconnect DRB-II to transmission diagnostic connector and note display.

2) If RAM TEST FAILURE message is not displayed, proceed with diagnostics. If RAM TEST FAILURE message is displayed, replace DRB-II and proceed with diagnostics. If KEYPAD TEST FAILURE message is displayed, replace DRB-II and proceed with diagnostics.

COMPONENT TESTING

BRAKE SWITCH

Brake switch is mounted above brake pedal. When brake pedal is operated, brake switch delivers an input signal to TCM. The TCM uses input signal for controlling No. 3 valve body solenoid for torque converter lock-up. No other information is available from manufacturer.

NOTE: For proper brake switch adjustment, see BRAKE SWITCH under REMOVAL & INSTALLATION.

NEUTRAL SAFETY SWITCH

NOTE: Neutral safety switch may be referred to as park/neutral or gear select switch. For proper neutral safety switch adjustment, see NEUTRAL SAFETY SWITCH under REMOVAL & INSTALLATION.

Disconnect electrical connector. Note terminal identification. See Fig. 4. Using ohmmeter, check continuity between specified terminals in relation to shift lever position. See NEUTRAL SAFETY SWITCH CONTINUITY SPECIFICATIONS table. Replace neutral safety switch if continuity is not as specified.

NEUTRAL SAFETY SWITCH CONTINUITY SPECIFICATIONS

Shift Lever Position	Continuity Between Terminals

Park	"B" & "C"
Reverse	"A" & "E"
Neutral	"B" & "C"
Drive	(1)
3	"A" & "G"
1-2	"A" & "H"

(1) - No continuity should exist between any terminals.

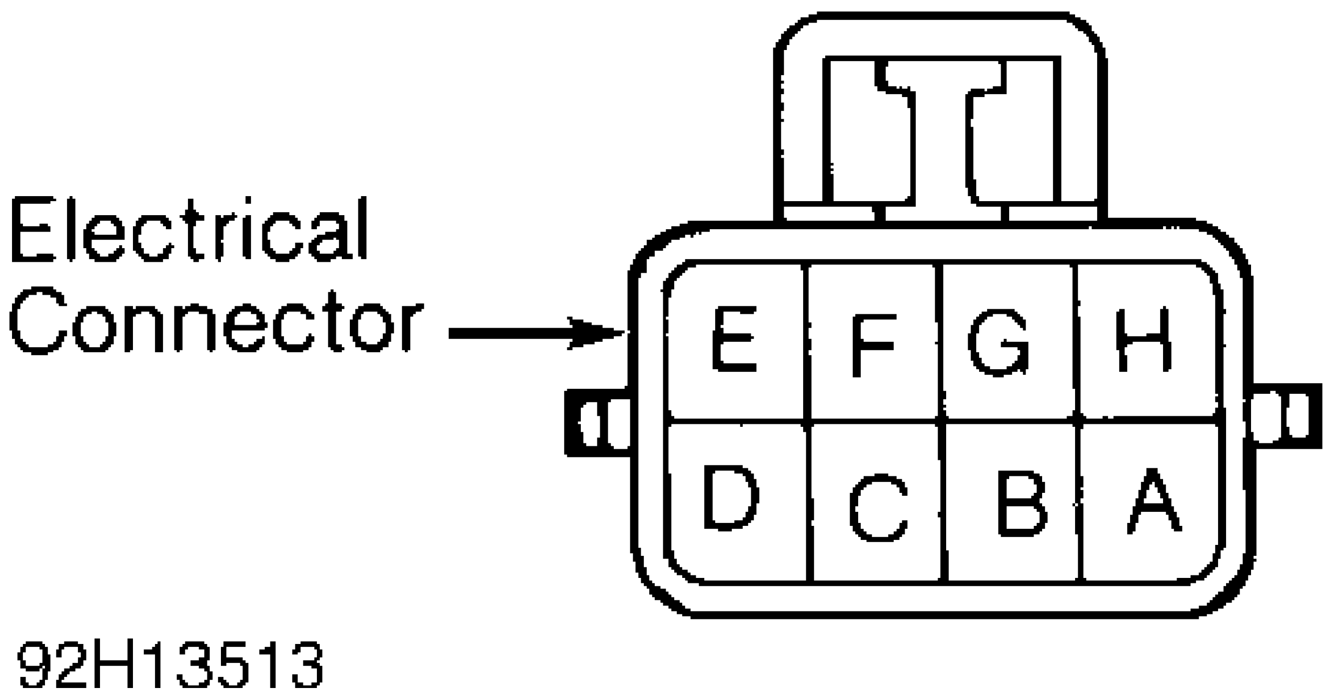


Fig. 4: Identifying Neutral Safety Switch Terminals
Courtesy of Chrysler Corp.

SPEED SENSOR

1) Disconnect electrical connector at speed sensor located on adapter housing or extension housing. Connect ohmmeter leads between speed sensor electrical terminals.

2) Rotate transmission output shaft and note ohmmeter reading. Ohmmeter needle should fluctuate to indicate speed sensor operation. Replace speed sensor if no reading is obtained.

THROTTLE POSITION SENSOR (TPS)

NOTE: Digital voltmeter must be used to check TPS.

1) Note location of TPS electrical connector. See Fig. 5. Turn ignition on. Using digital voltmeter, check output voltage at center terminal with throttle plate closed (idle position) and wide open (full throttle).

2) With throttle plate closed (idle position), output voltage should be greater than 200 millivolts. With throttle plate wide open (full throttle), output voltage should be less than 4.8 volts.

3) Ensure output voltage gradually increases as throttle plate is moved from closed to wide open throttle. If no voltage exists, check for defective wiring circuits or connections. Replace TPS if defective.

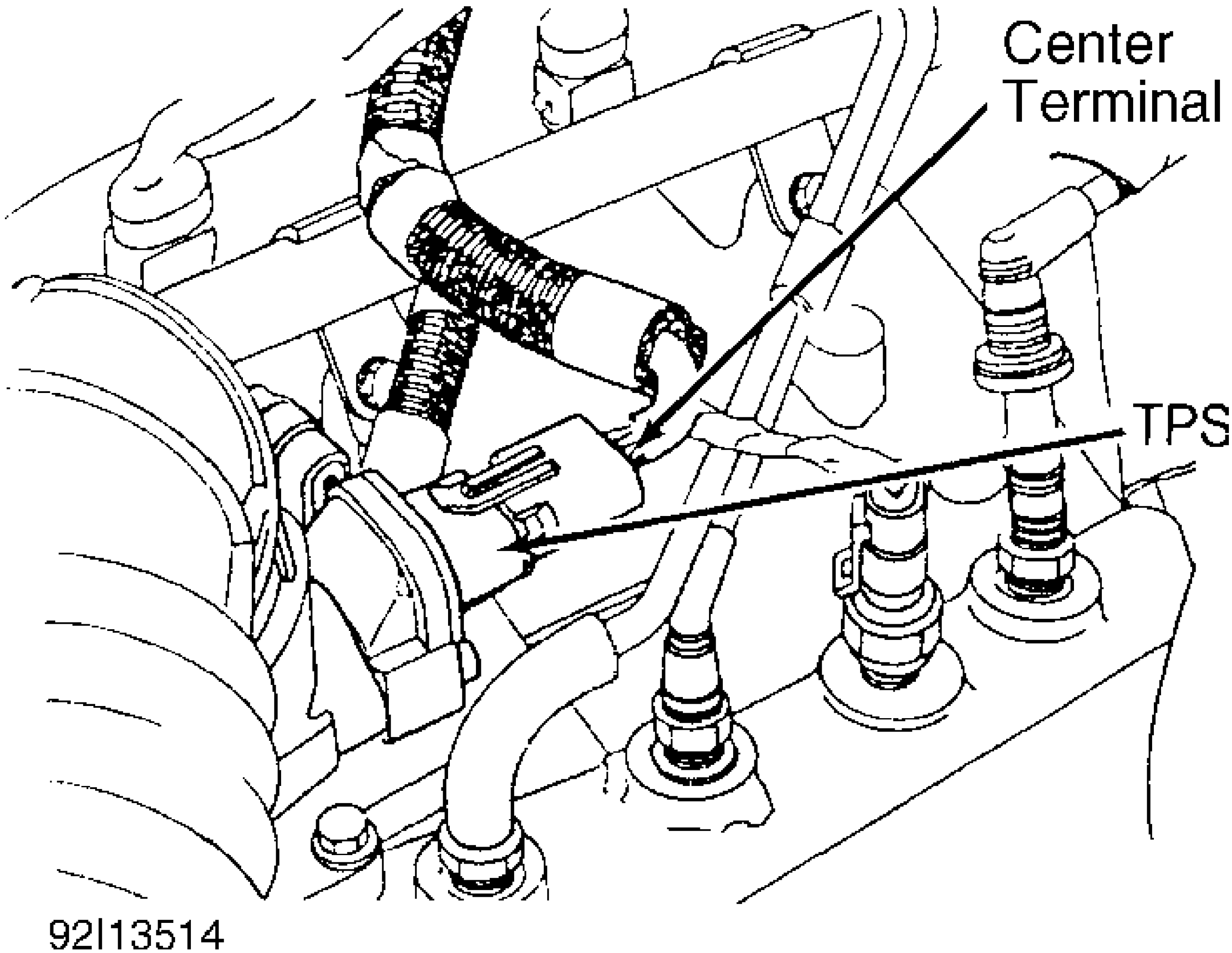


Fig. 5: Identifying TPS Electrical Connector
Courtesy of Chrysler Corp.

VALVE BODY SOLENOID

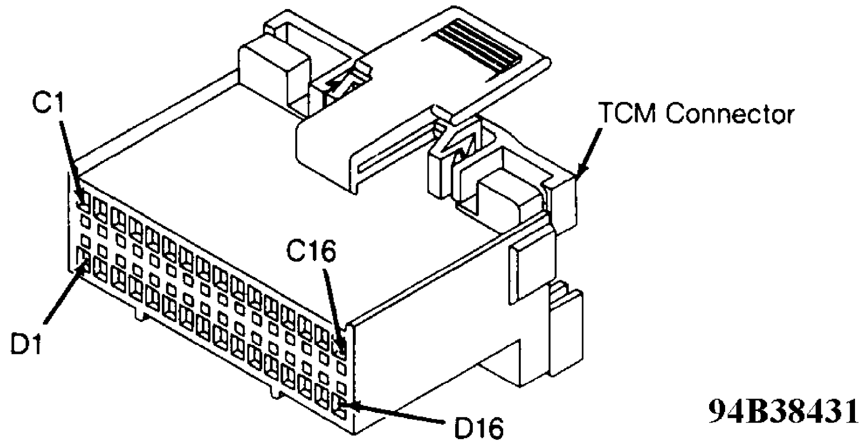
With oil pan removed, disconnect electrical connector from valve body solenoid. Using ohmmeter, check resistance between valve body solenoid electrical terminal and solenoid mounting bracket. Replace valve body solenoid if resistance is not 11-15 ohms.

TROUBLE SHOOTING CHARTS & CODE CHARTS

NOTE: Following trouble shooting charts and illustrations are courtesy of Chrysler Corp. Always start by performing TEST 1A - VERIFICATION OF THE COMPLAINT. When diagnosing transmission, it may be necessary to verify TCM connector terminals, circuits and function, See Fig. 6.

NOTE: When using trouble shooting charts, Transmission Control Module (TCM) may be referred to as Transmission Control Unit (TCU). Diagnostic trouble code may be referred to as fault code. Neutral safety switch may be referred to as

park/neutral or gear select switch.



CHEROKEE

CAV	CIRCUIT	FUNCTION
C1-C2		Not Used
C3	505 TN/BK	Trans Speed Sensor
C4	137 YL/BK	Auto Trans Diagnostic
C5-C7		Not Used
C8	506 LG/BK	Low (1-2) Input
C9	507 GY/BK	Drive (3) Input
C10	K29 WT/PK	Brake Input
C11		Not Used
C12-C13		Not Used
C14	508 WT/BK	S3 Solenoid (Converter Lockup)
C15	509 VT/WT	S2 Solenoid
C16	510 DB/WT	S1 Solenoid
D1		Not Used
D2	K22 OR/DB	Throttle Position Sensor
D3	K4 BK/LB	TPS Signal Ground
D4-D6		Not Used
D7	Z12 BK/TN	Power Ground
D8-D13		Not Used
D14	A14 RD	Battery
D15		Not Used
D16	T17 YL	Ignition (Run/On)

GRAND CHEROKEE

CAV	CIRCUIT	FUNCTION
C1-C2		Not Used
C3	T14 LG/WT	Trans Speed Sensor
C4	D82 BK/YL	Auto Trans Diagnostic
C5-C7		Not Used
C8	T25 LG	Low (1-2) Input
C9	T50 DG	Drive (3) Input
C10	L53 BR	Brake Input
C11-C13		Not Used
C14	T20 LB/BR	S3 Solenoid (Converter Lockup)
C15	T59 PK	S2 Solenoid
C16	T60 BR/YL	S1 Solenoid
D1		Not Used
D2	K22 OR/DB	Throttle Position Sensor
D3	K4 BK/LB	TPS Signal Ground
D4-D6		Not Used
D7	Z1 BK	Power Ground
D8-D13		Not Used
D14	A14 RD/WT	Battery
D15		Not Used
D16	F86 LB/RD	Ignition (Run/On)

Fig. 6: TCM Connector Terminals I.D., Circuits & Functions
Courtesy of Chrysler Corp.

TEST 1A - VERIFICATION OF THE COMPLAINT

NOTE: ALWAYS start diagnosis with the most recent code.

1) Begin your testing of the transmission with a thorough visual inspection.

2) Connect the DRB-II to the transmission diagnostic connector. See RETRIEVING FAULT CODES under SELF-DIAGNOSTIC SYSTEM for diagnostic connector location.

CAUTION: If the vehicle is in 3rd or OD position and feels like it is stuck in 3rd or jumping from 2-1 or 3-1, perform TEST 10A - TESTING FOR INTERMITTENT SPEED SENSOR test below.

3) With the DRB-II, perform SYSTEM TEST. See SYSTEM TEST MODE under DRB-II OPERATING MODES.

4) The DRB-II will instruct you to do some actions during the System Test. The DRB-II will then look for the action to happen and automatically go to the next test function. If you perform the required action and the DRB-II does not move to the next function, press ENTER. The DRB-II will continue the testing.

5) When the DRB-II states "VEHICLE DRIVE", the vehicle be must be driven at a speed above 4 miles per hour to ensure accurate testing of the vehicle speed sensor. Afterwards, the DRB-II will display any fault codes that may be present.

6) When the system test is complete, if there are any fault codes present, the DRB-II will automatically display the code(s).

7) There are two types of faults for the transmission solenoids. They are displayed as "FAULT STORED" and "FAULT PRESENT". Note that the tests are different in the chart below.

8) Perform the tests shown below in response to the indicated fault codes.

NOTE: ALWAYS start diagnosis with the most recent code.

CODE-TO-TEST MENU

CODE-TO-TEST MENU

Code:	Solenoid Affected:	Fault Status:	Perform:
None	None Affected	No Faults	Test 2A
700	Solenoid No. 1	Fault Present	Test 4A
700	Solenoid No. 1	Fault Stored	Test 3A
700	Solenoid No. 2	Fault Present	Test 4B
700	Solenoid No. 2	Fault Stored	Test 3A
700	Solenoid No. 3	Fault Present	Test 4C
700	Solenoid No. 3	Fault Stored	Test 3A
702	Speed Sensor Fault		Test 5A
703	Gear Select Fault		Test 6A
705	TPS Fault		Test 7A
708	Wrong TCU		Test 9A

TEST 2A - VERIFICATION TEST

NOTE: Perform TEST 1A - VERIFICATION OF THE COMPLAINT before proceeding.

This test verifies the correct operation of the AW4 transmission. It must be performed after finding no faults using the DRB-II, and after a vehicle repair has been made.

1) Turn ignition key to "OFF".
2) Hold the MODE key and press the ATM key on the DRB-II at the same time to restart the DRB-II.
3) Turn ignition key to "ON".
4) Reconnect all previously disconnected connectors.
5) Verify that the AW4 transmission control unit is properly mounted.
6) Make sure the transmission fluid is at the proper level. Check the fluid with the transmission temperature hot, the vehicle on level ground, and the gear selector in neutral.
7) If any repairs have been made, test the vehicle as instructed in TEST 1A - VERIFICATION OF THE COMPLAINT, and read faults using the DRB-II. If there are any fault messages present, repeat TEST 1A - VERIFICATION OF THE COMPLAINT.

TEST 3A - STORED DIAGNOSTIC TROUBLE CODES TEST

NOTE: Perform TEST 1A - VERIFICATION OF THE COMPLAINT before proceeding.

1) At this point, the Visual Inspection has been performed, a "FAULT STORED" code has been found and the vehicle has been test driven. The fault code is not "FAULT PRESENT", so it cannot be considered a CURRENT or HARD fault.
2) All solenoid circuits are in the same harness and a common ground wire is used for the solenoids. Use the following figures to identify the harness and connector to inspect. See Fig. 7 and 8. if all 3 solenoid faults are present, repair the Black wire (Cherokee) ground wire open condition.
3) Carefully inspect the entire suspected circuit. Pay particular attention to connectors, corrosion, accident damage, and improper or missing parts.
4) If any problems are found, make the appropriate repair. Then perform TEST 1A using the DRB-II.
5) Erase fault codes.
6) If no problems are found, perform the SYSTEM TEST using the DRB-II. Re-check for fault codes. If there are no fault codes, perform TEST 2A - VERIFICATION TEST. If fault code(s) return, perform TEST 1A - VERIFICATION OF THE COMPLAINT.

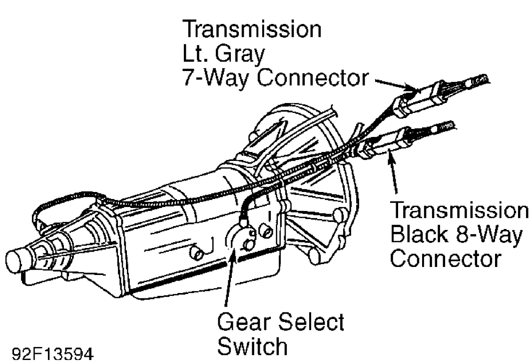
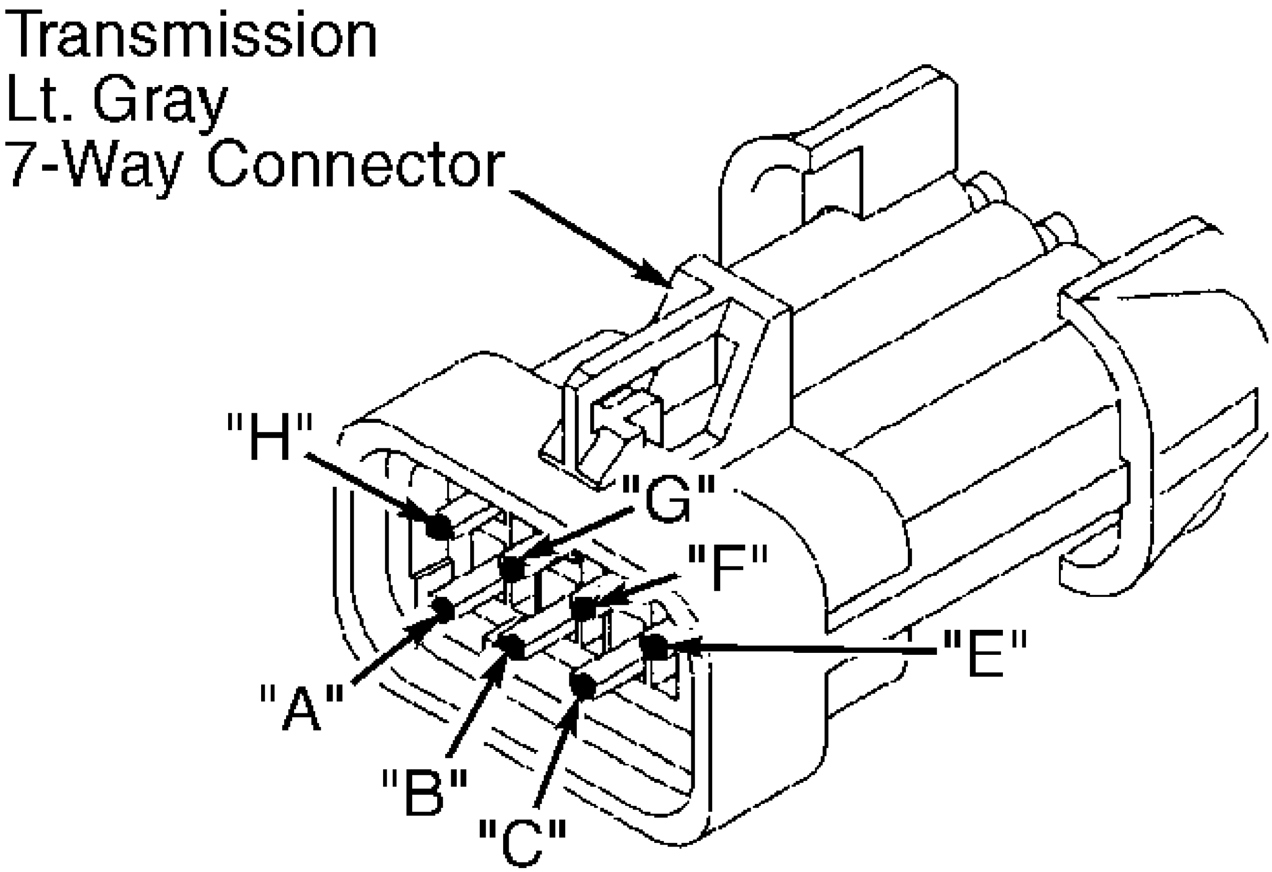


Fig. 7: Test 3A - Location of 7-Way Connector



A	B	C	E	F	G	H
BK/YL	BK/TN	TN/WT	WT/BK	VT/WT	DB/WT	BK/RD

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Fig. 8: Test 3A - View of 7-Way Connector (Cherokee)

TEST 4A - CODE 700 - S1 SOLENOID CIRCUIT

Perform TEST 1A before proceeding.

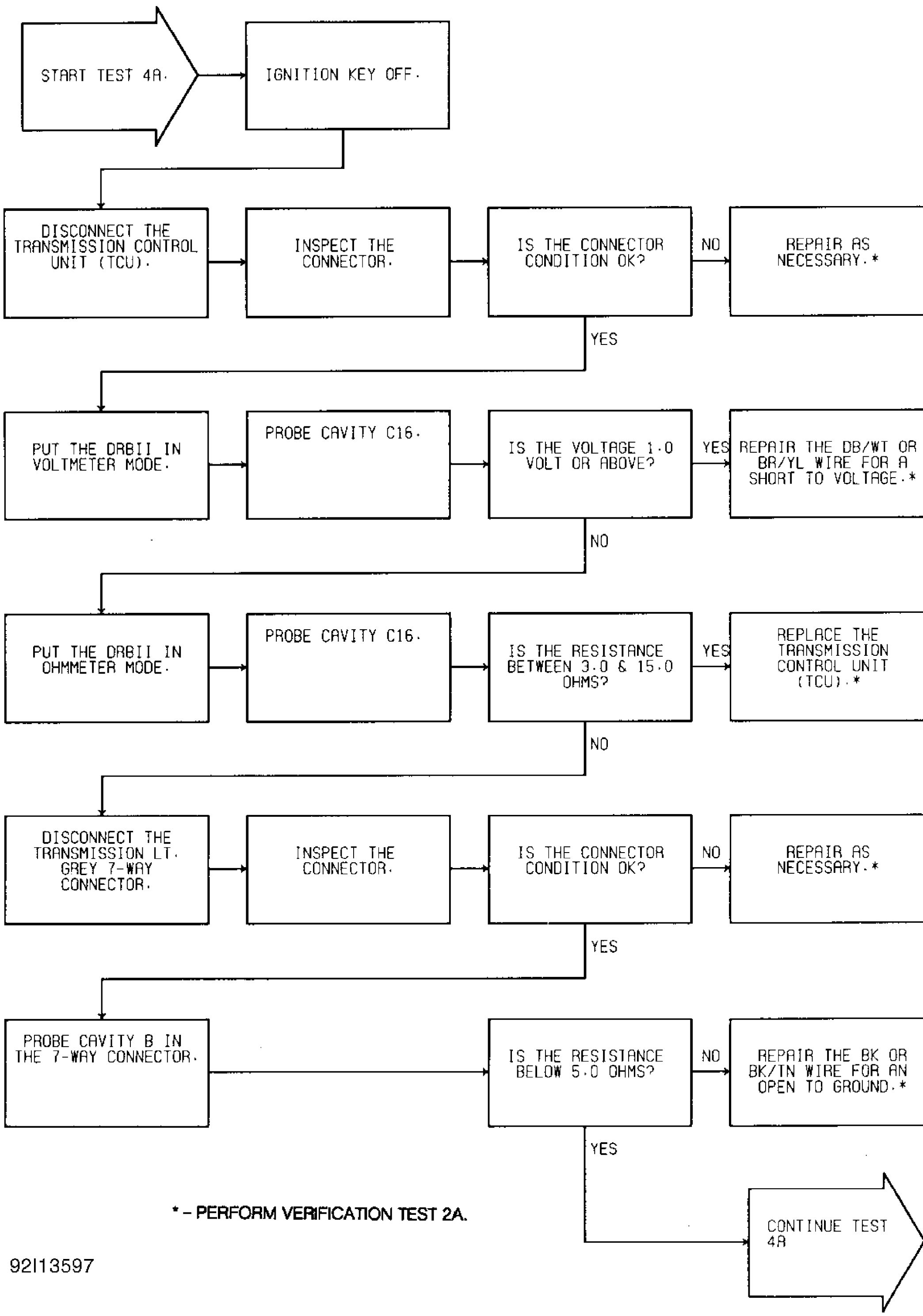


Fig. 9: Test 4A - Code 700, Flow Chart (1 of 2)

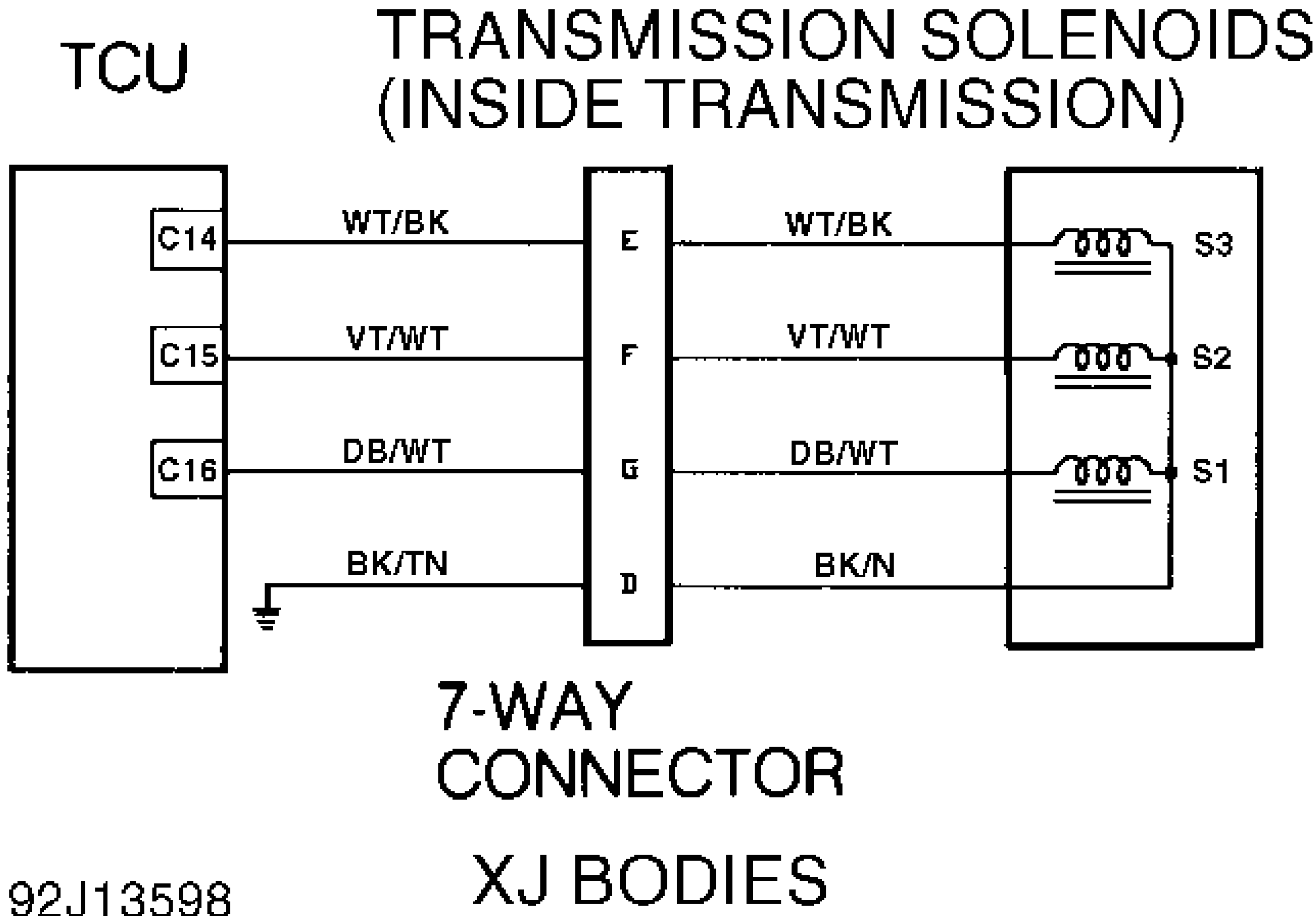


Fig. 10: Test 4A - Code 700, Schematic (Cherokee)

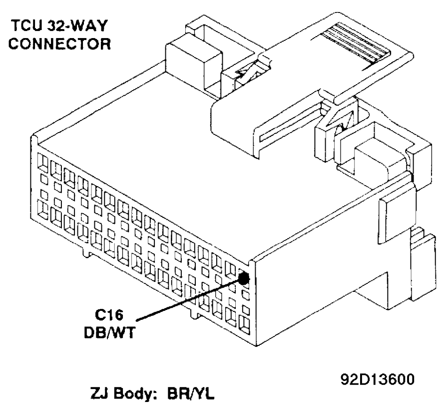


Fig. 11: Test 4A - Code 700, TCU 32-Way Connector (Cavity 16)

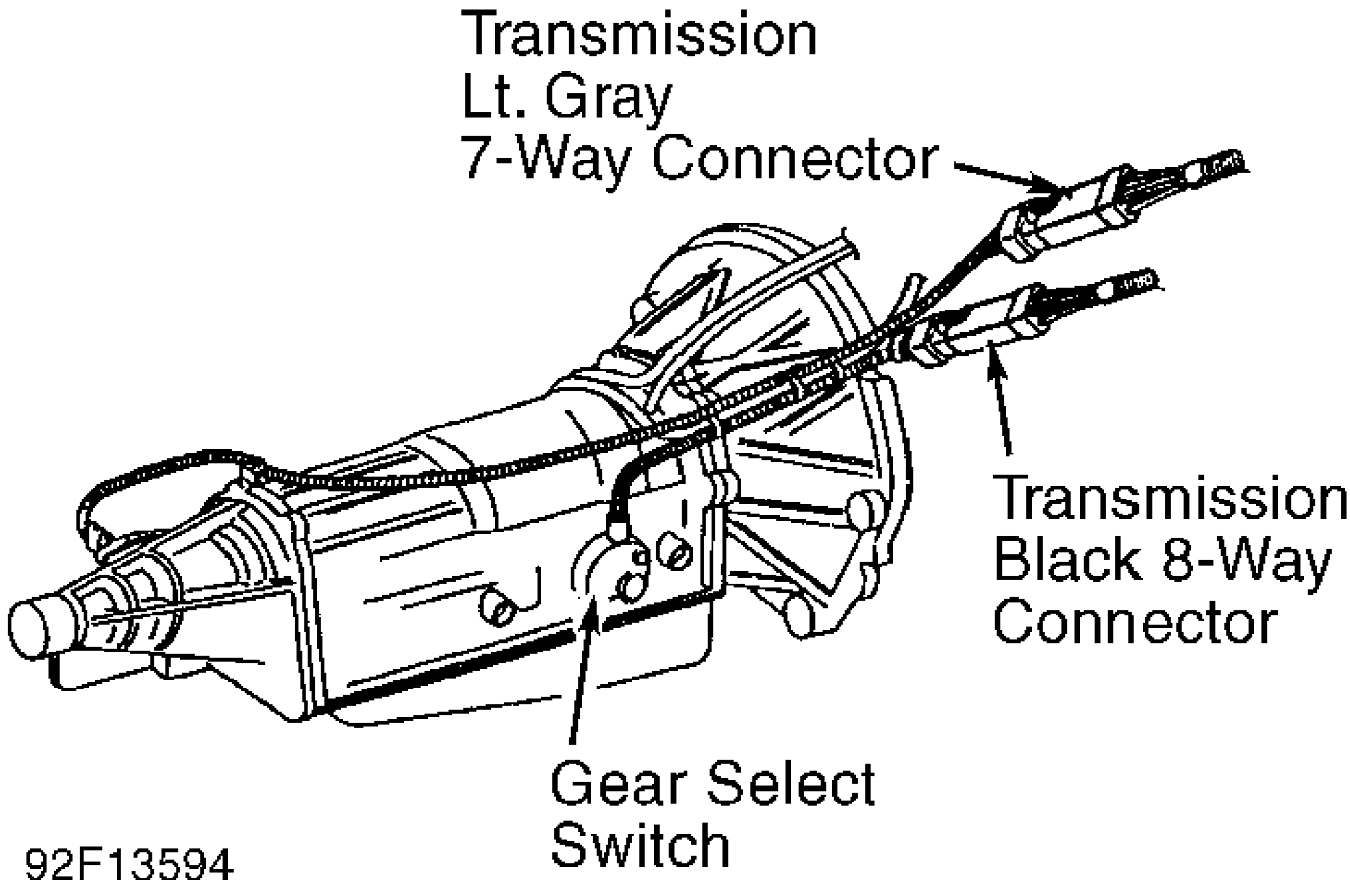


Fig. 12: Test 4A - Code 700, Location of 7-Way Connector

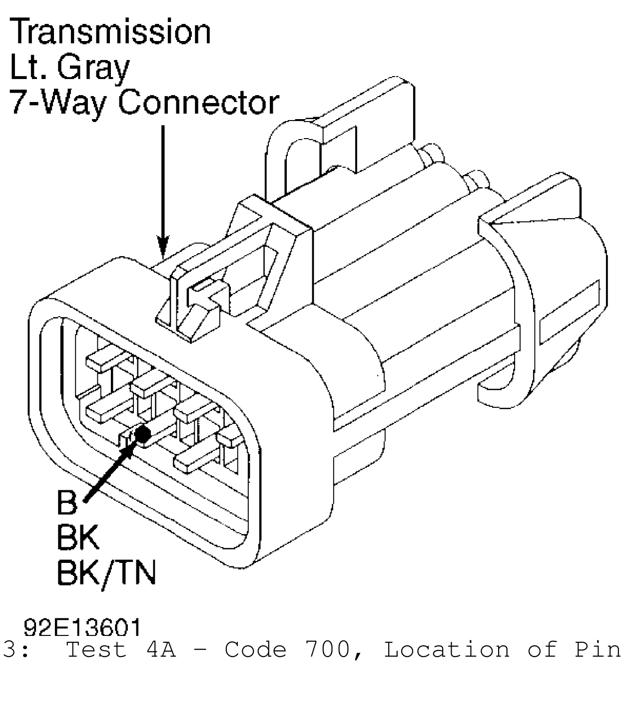
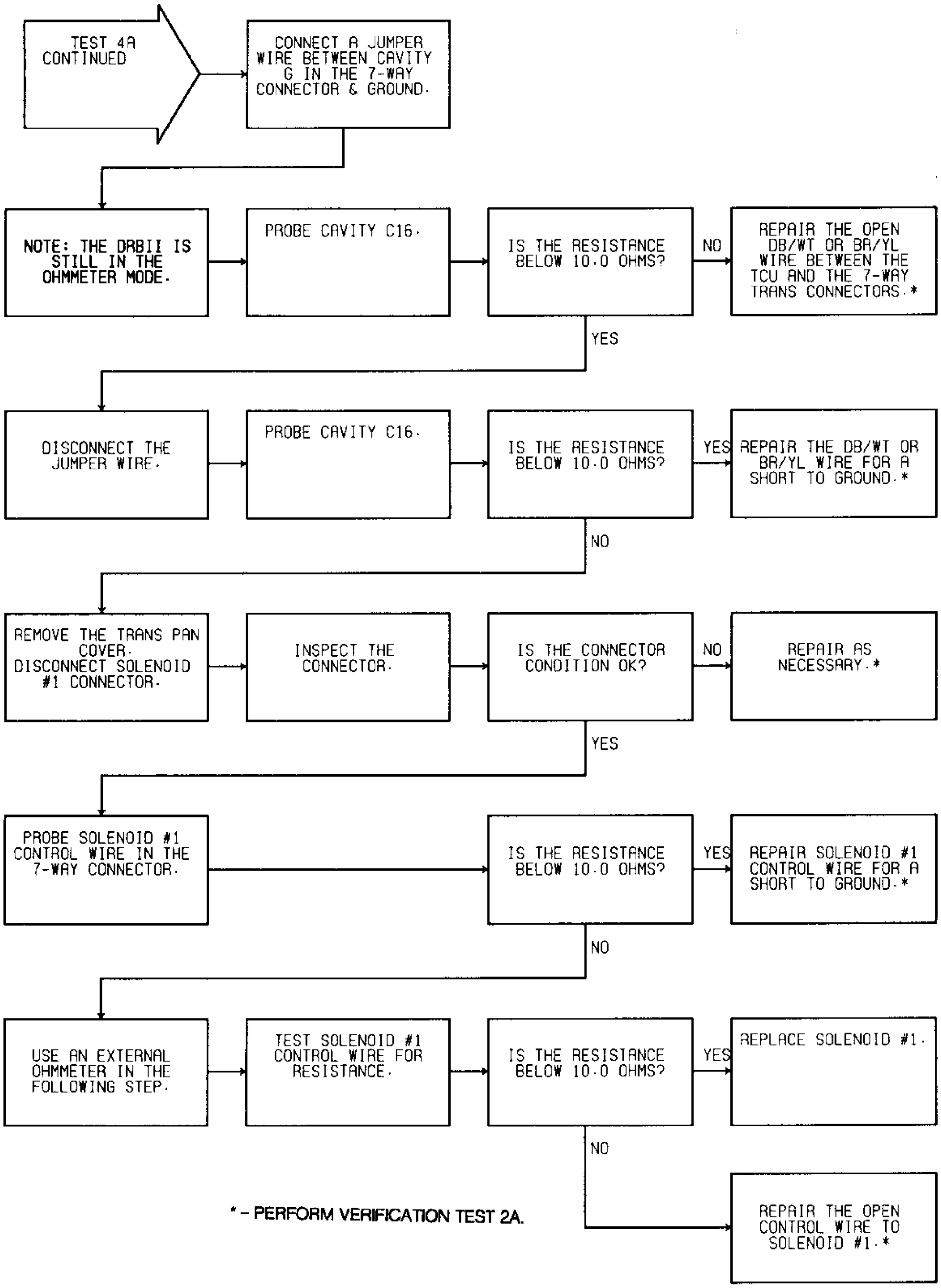


Fig. 13: Test 4A - Code 700, Location of Pin "B" (Ground)



NOTE: See TEST 4A (1 OF 2) for wiring diagram.

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Fig. 14: Test 4A - Code 700, Flow Chart (2 of 2)

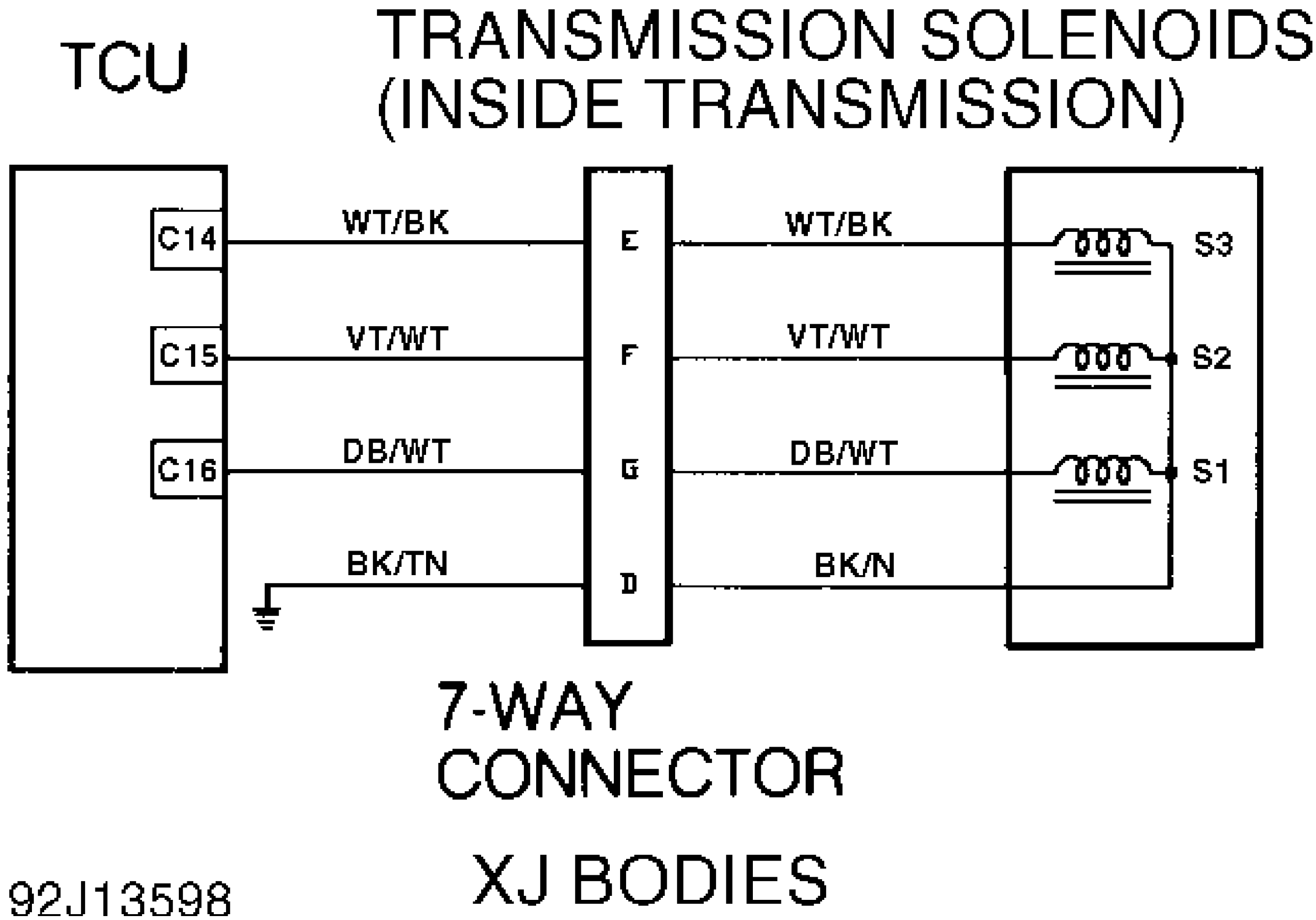


Fig. 15: Test 4A - Code 700, Schematic (Cherokee)

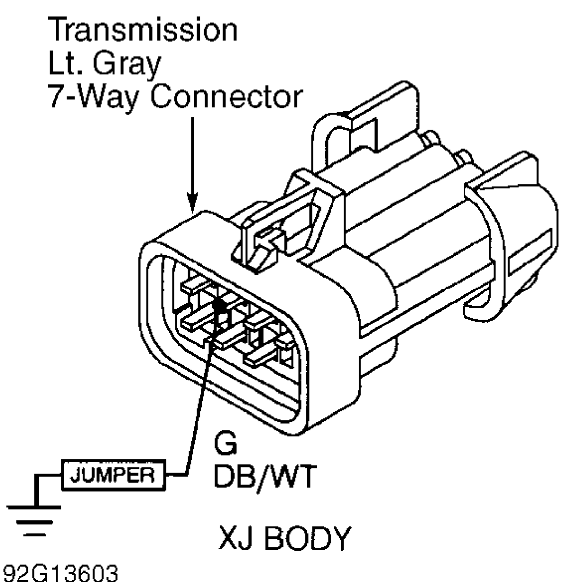


Fig. 16: Test 4A - 7-Way Connector Cavity "G" (Cherokee)

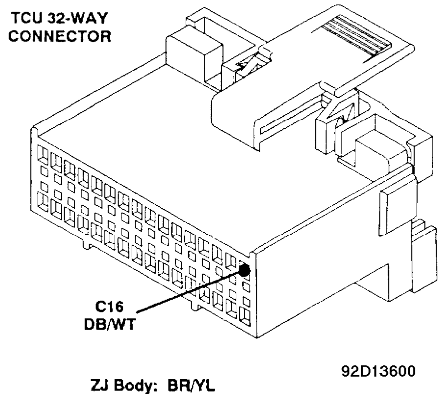


Fig. 17: Test 4A - Code 700, TCU 32-Way Connector (Cavity 16)

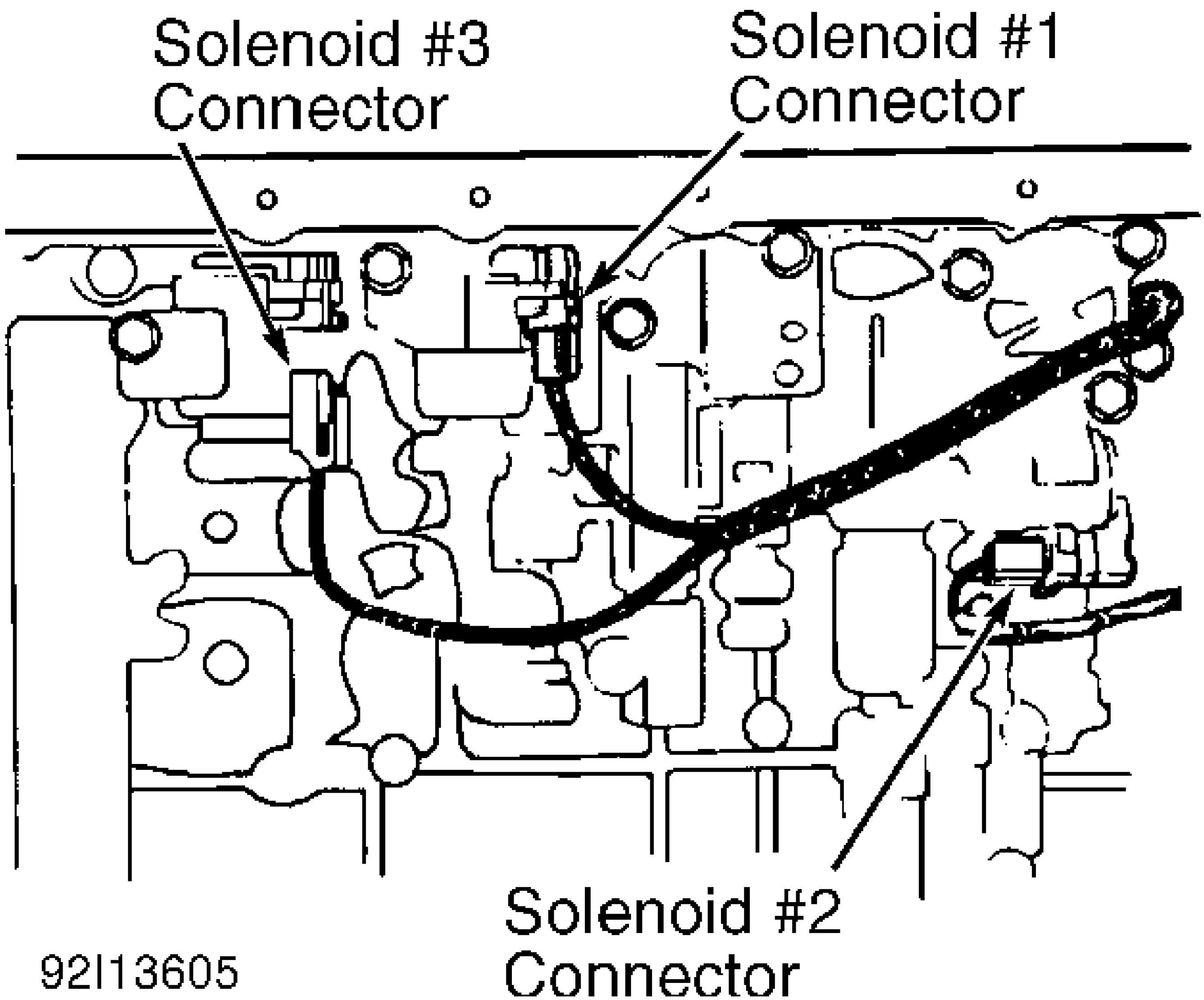
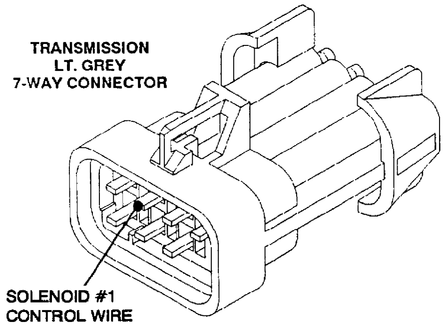


Fig. 18: Test 4A - Code 700, Location of Solenoids



CAV	MJ/XJ	ZJ
G	DB/WT	BR/YL

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Fig. 19: Test 4A - Code 700, Solenoid No. 1 Wire (Cavity "G")

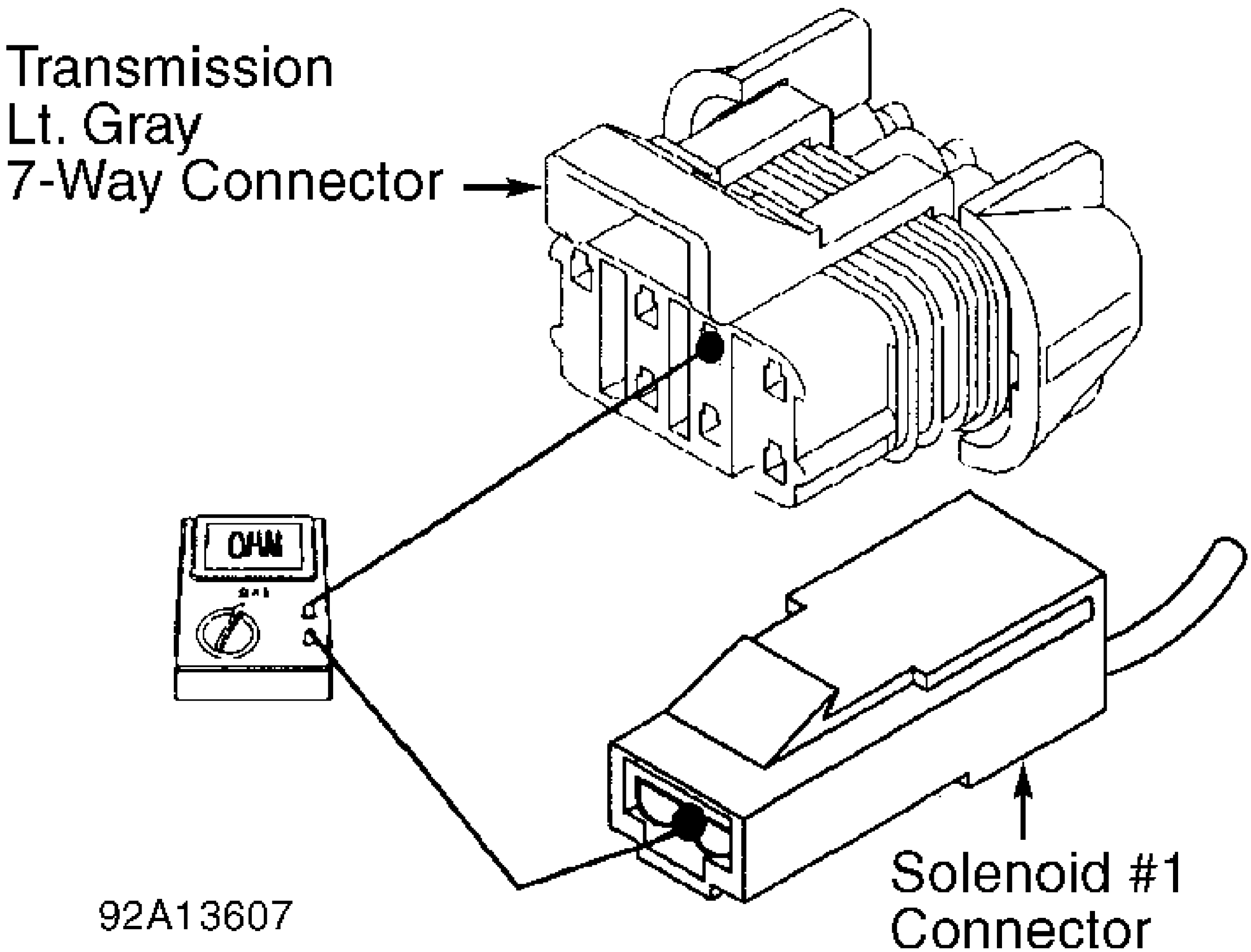


Fig. 20: Test 4A - Code 700, Testing S1 Control Wire

TEST 4B - CODE 700 - S2 SOLENOID CIRCUIT

Perform TEST 4A before proceeding.

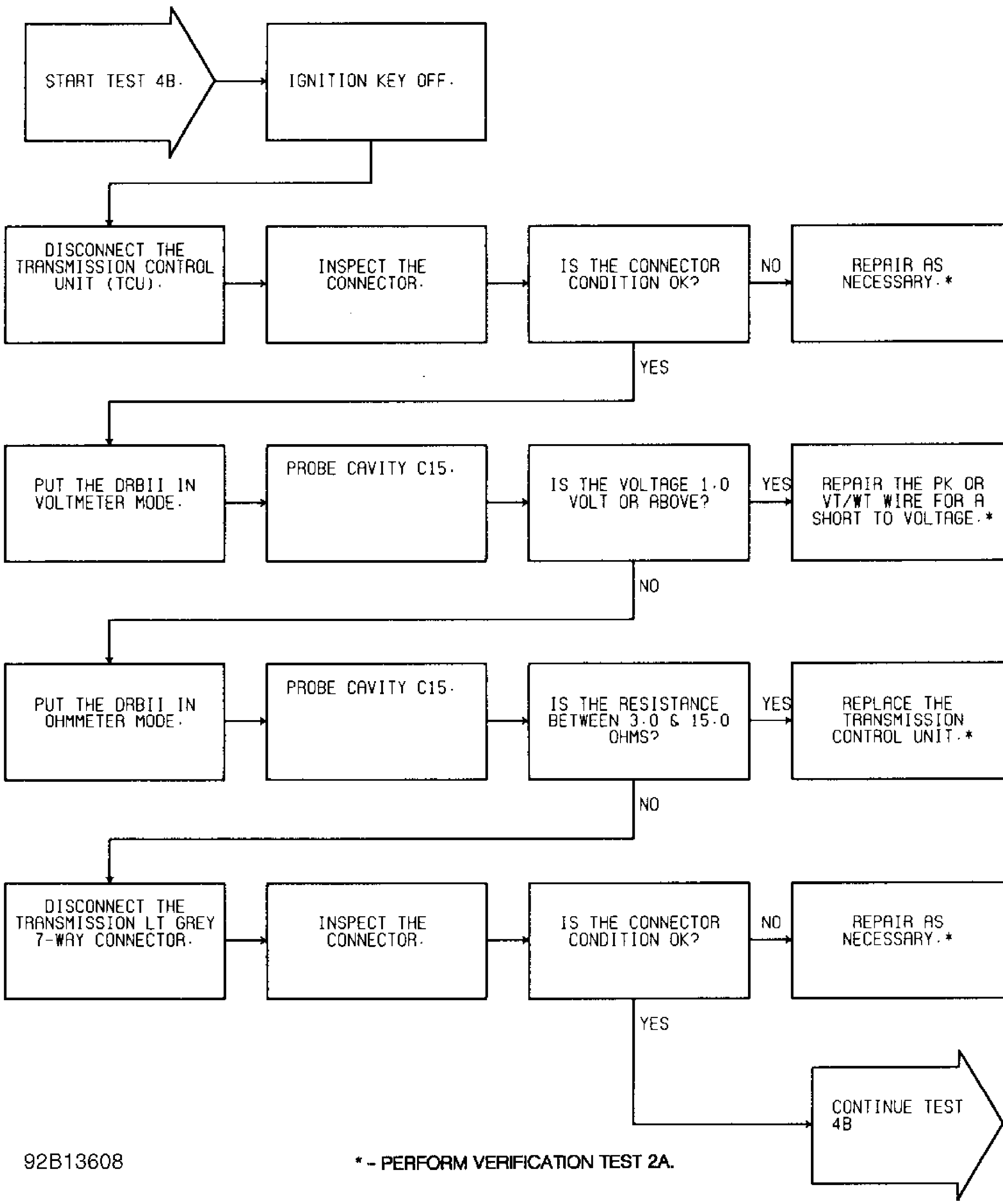


Fig. 21: Test 4B - Code 700, Flow Chart (1 of 2)

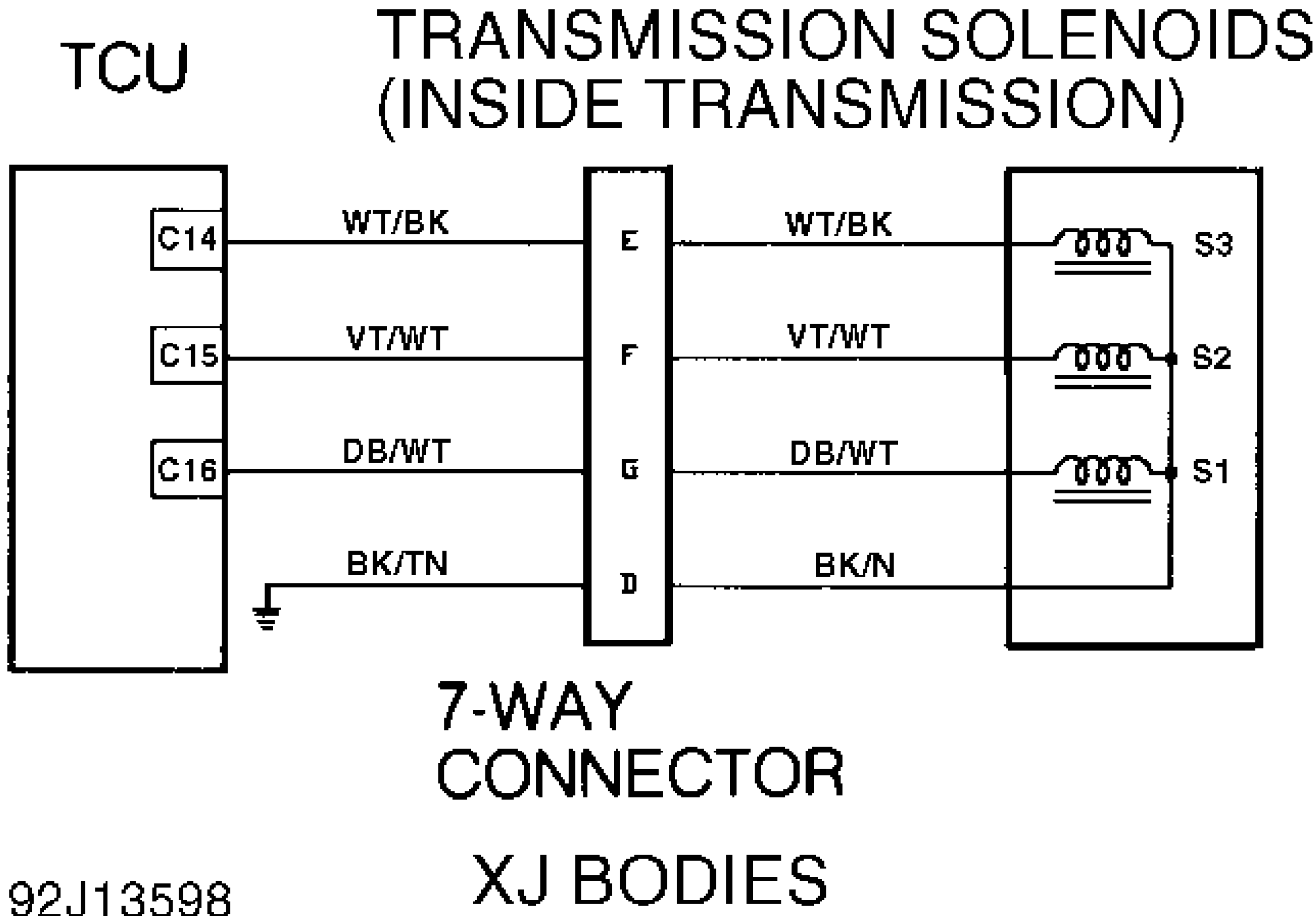
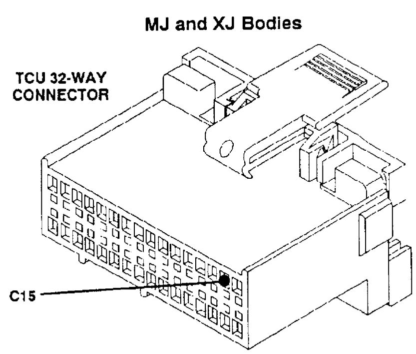


Fig. 22: Test 4B - Code 700, Schematic (Cherokee)



CAV	MJ/XJ	ZJ
C15	VT/WT	PK

Fig. 23: Test 4B - Code 700, TCU 32-Way Connector (Cavity 15)

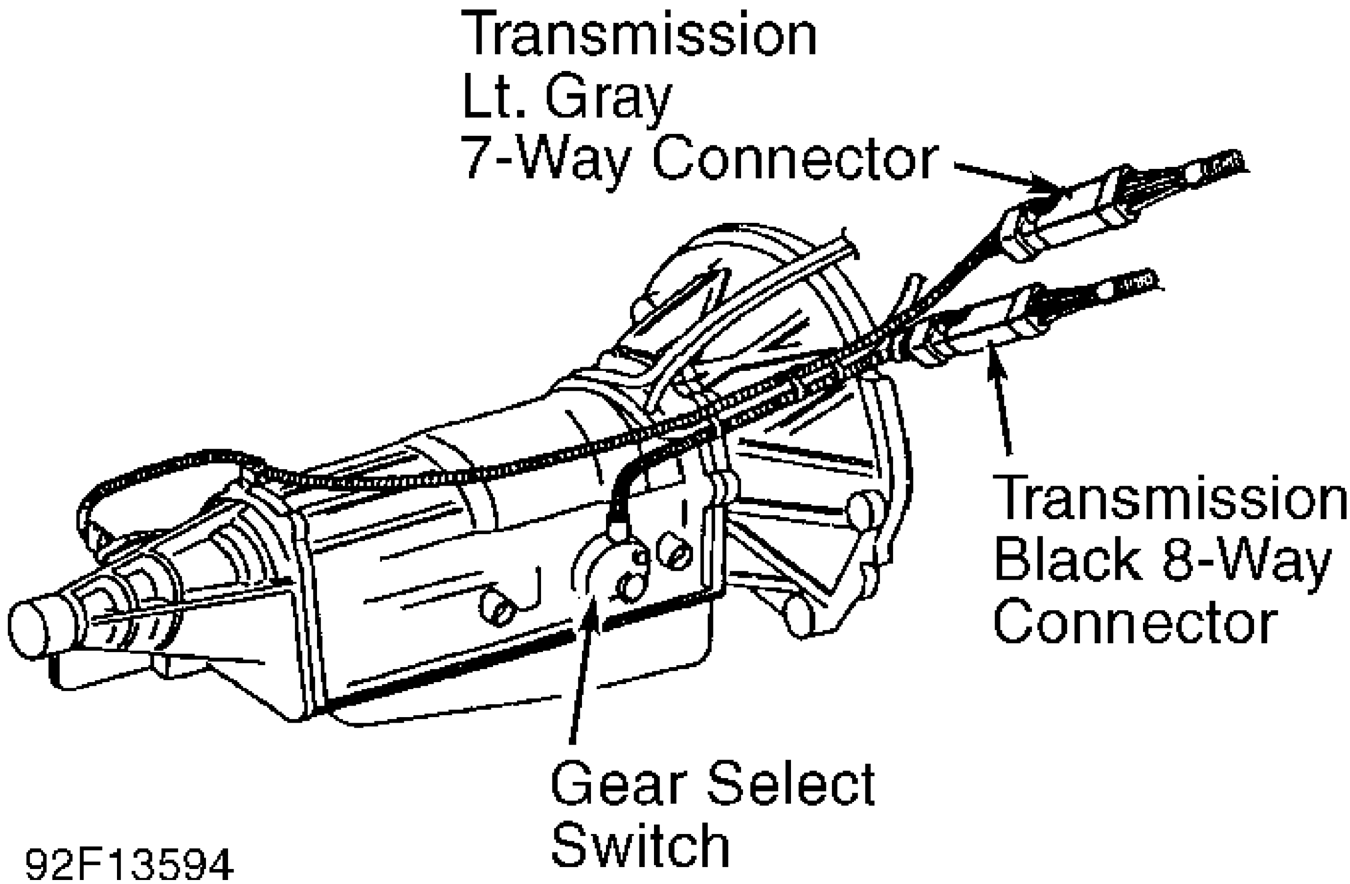
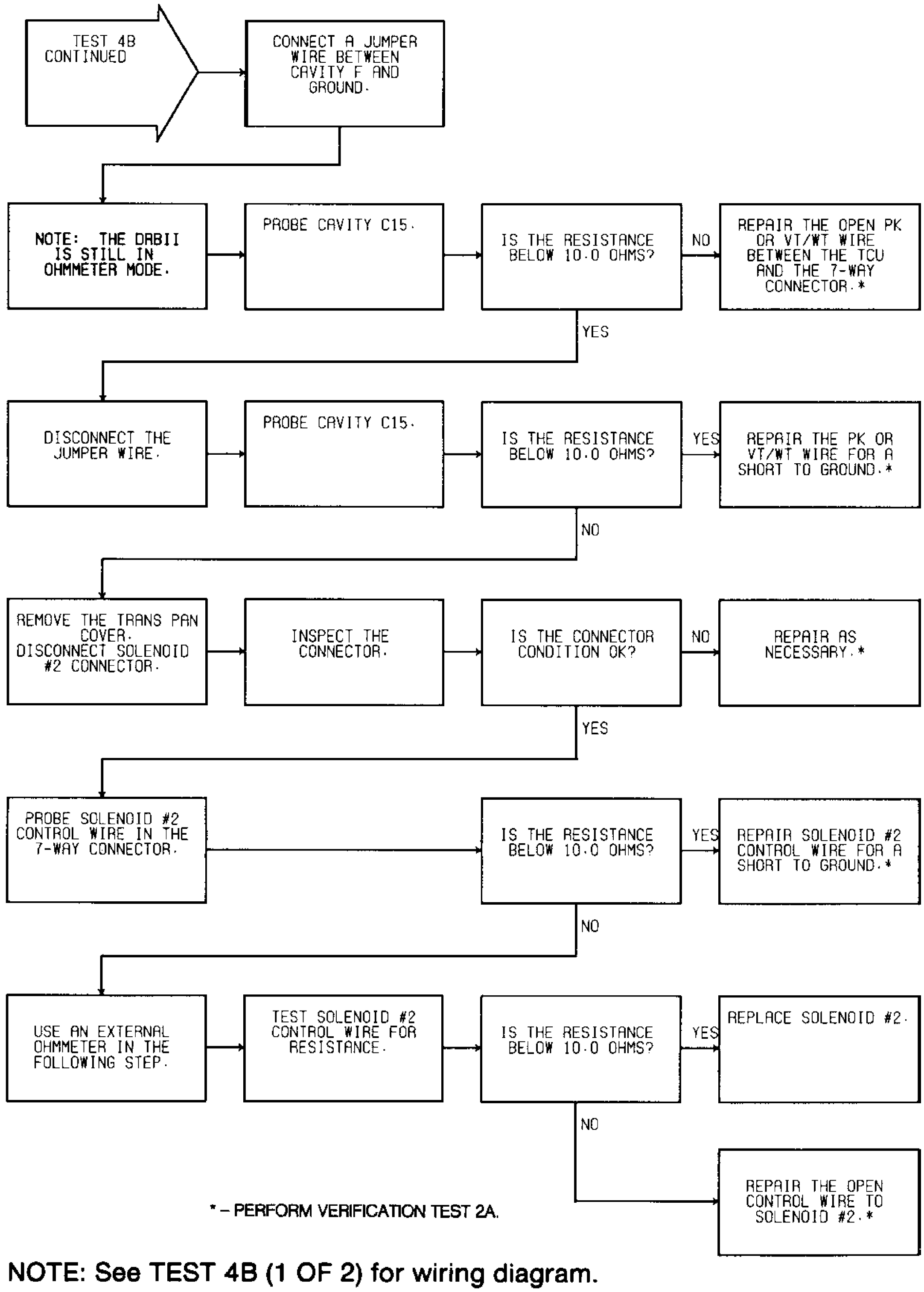
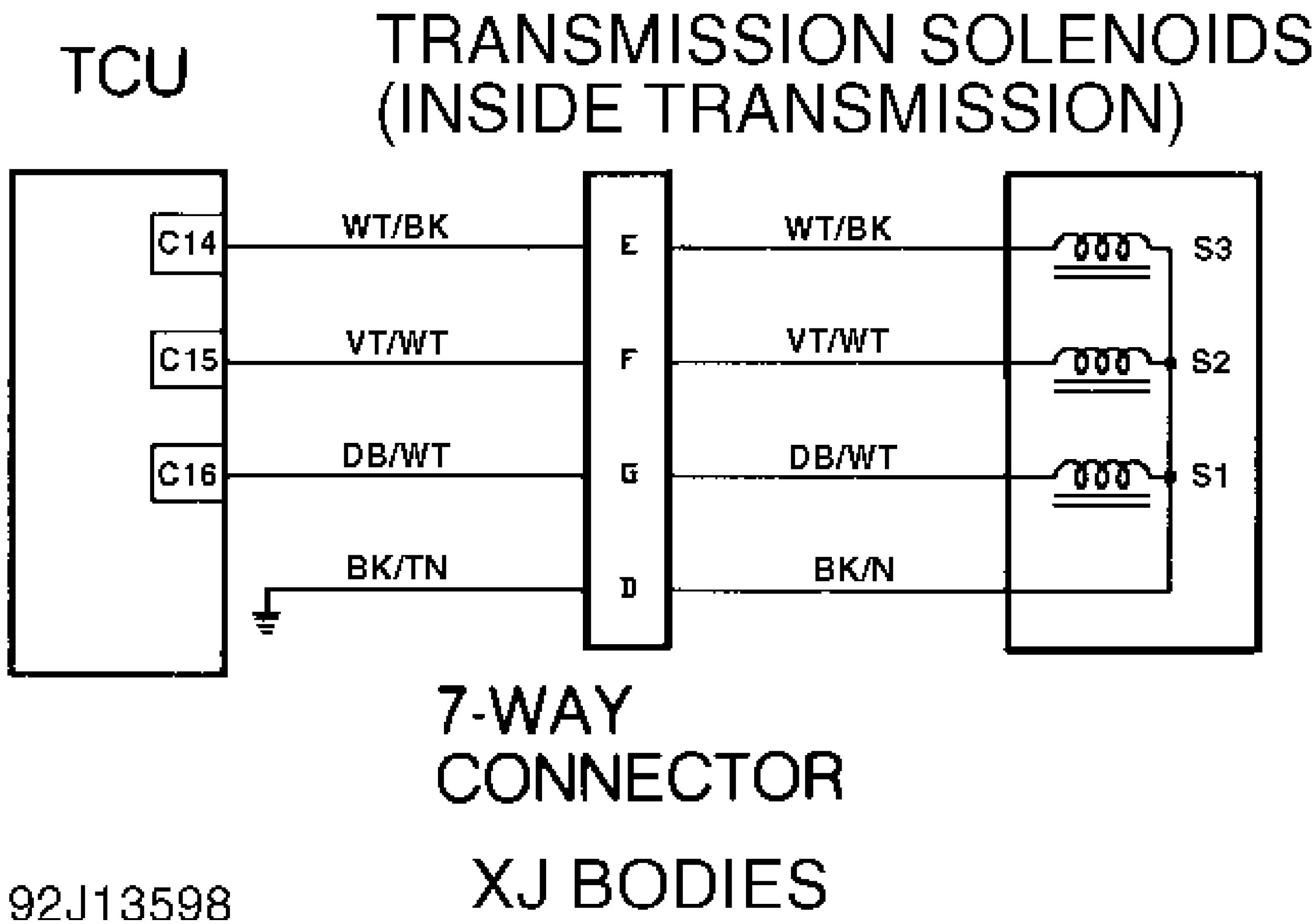


Fig. 24: Test 4B - Code 700, Location of 7-Way Connector



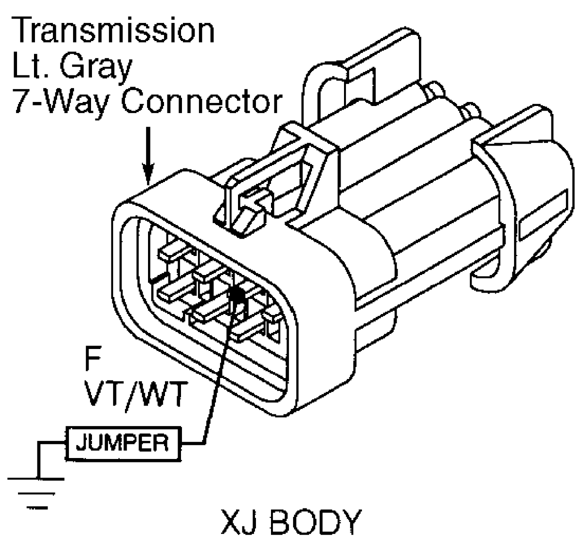
92F13610

Fig. 25: Test 4B - Code 700, Flow Chart (2 of 2)



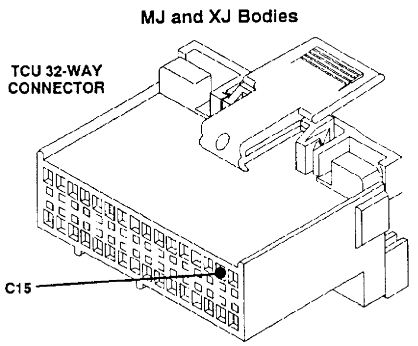
92J13598

Fig. 26: Test 4B - Code 700, Schematic (Cherokee)



92G13611

Fig. 27: Test 4B - 7-Way Connector Cavity "F" (Cherokee)



CAV	MJ/XJ	ZJ
C15	VT/WT	PK

92C13609

Fig. 28: Test 4B - Code 700, TCU 32-Way Connector (Cavity 15)

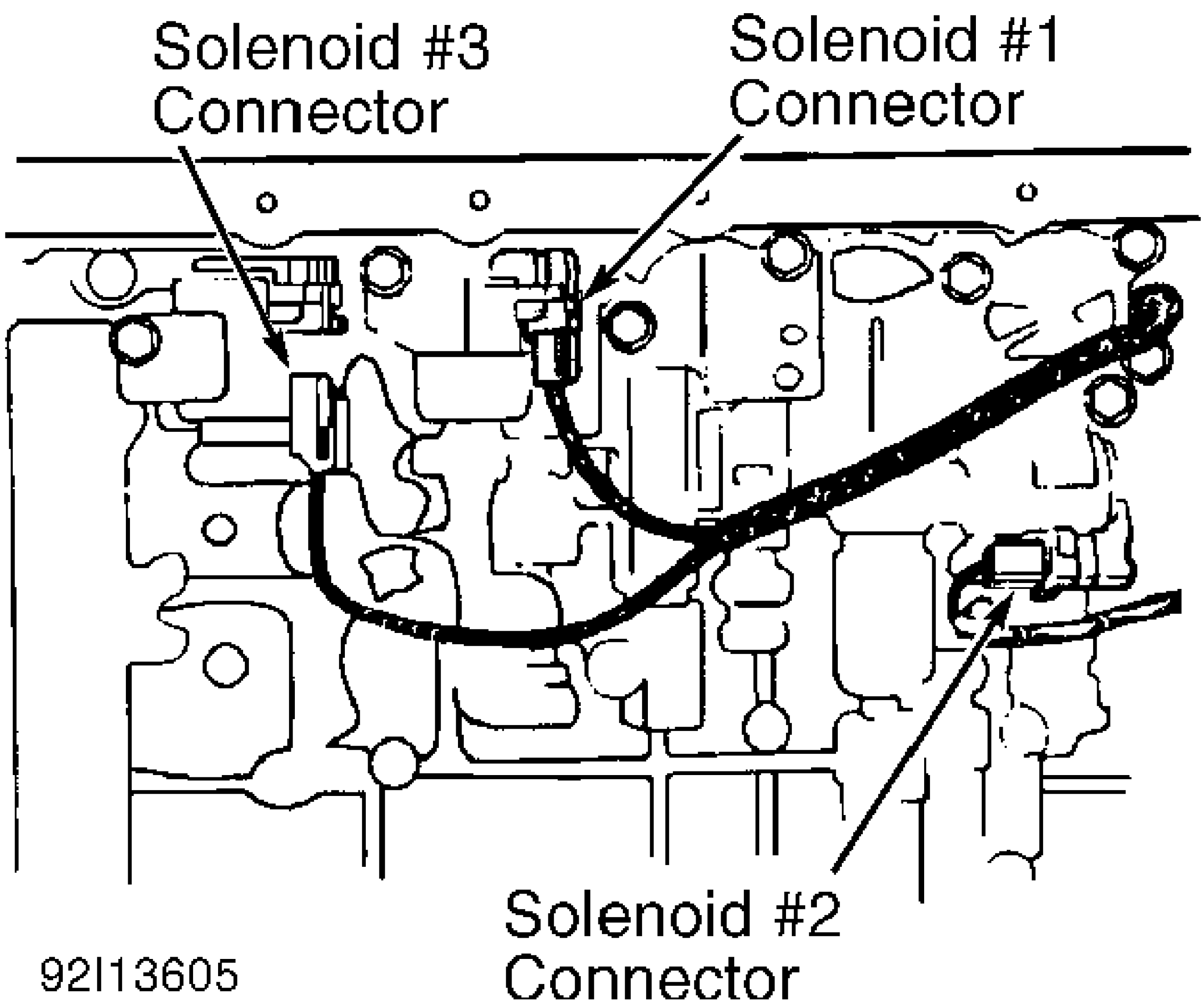
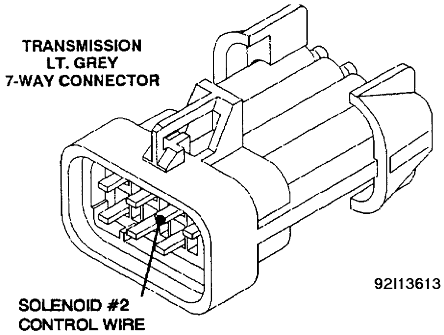


Fig. 29: Test 4B - Code 700, Location of Solenoids



CAV	MJ/XJ	ZJ
F	VT/WT	PK

Fig. 30: Test 4B - Code 700, Solenoid No. 1 Wire (Cavity "F")

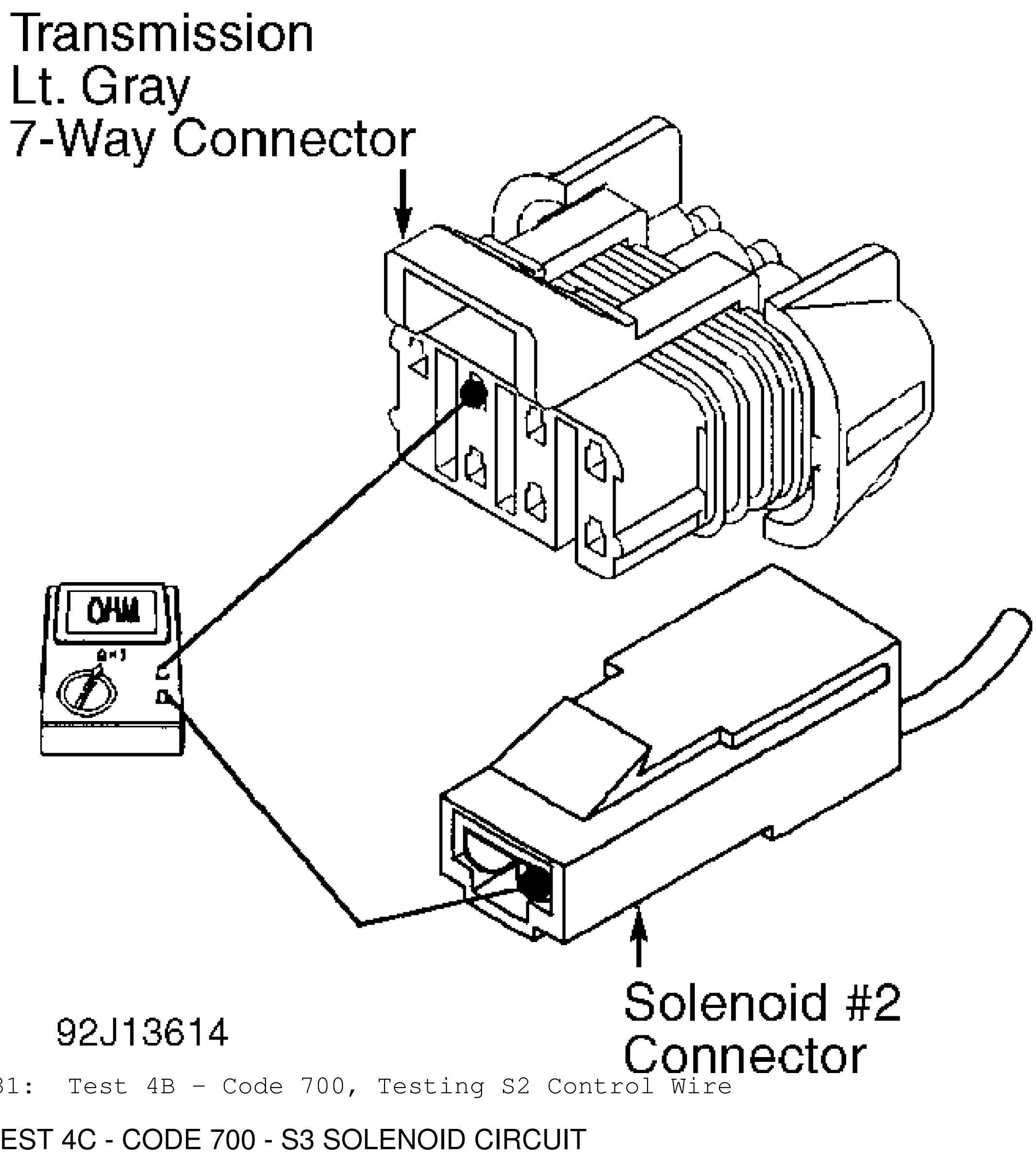


Fig. 31: Test 4B - Code 700, Testing S2 Control Wire

TEST 4C - CODE 700 - S3 SOLENOID CIRCUIT

Perform TEST 4A before proceeding.

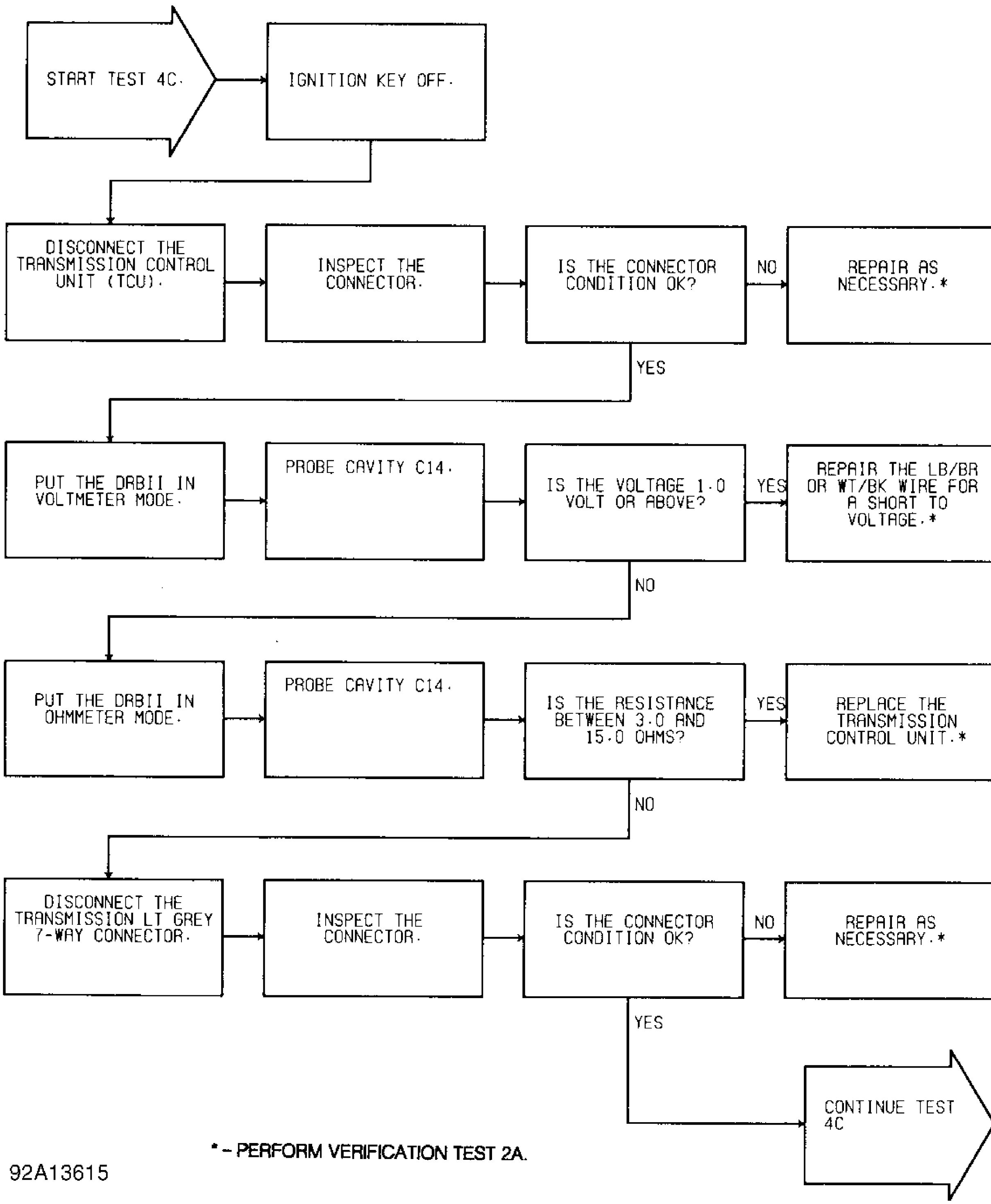


Fig. 32: Test 4C - Code 700, Flow Chart (1 of 2)

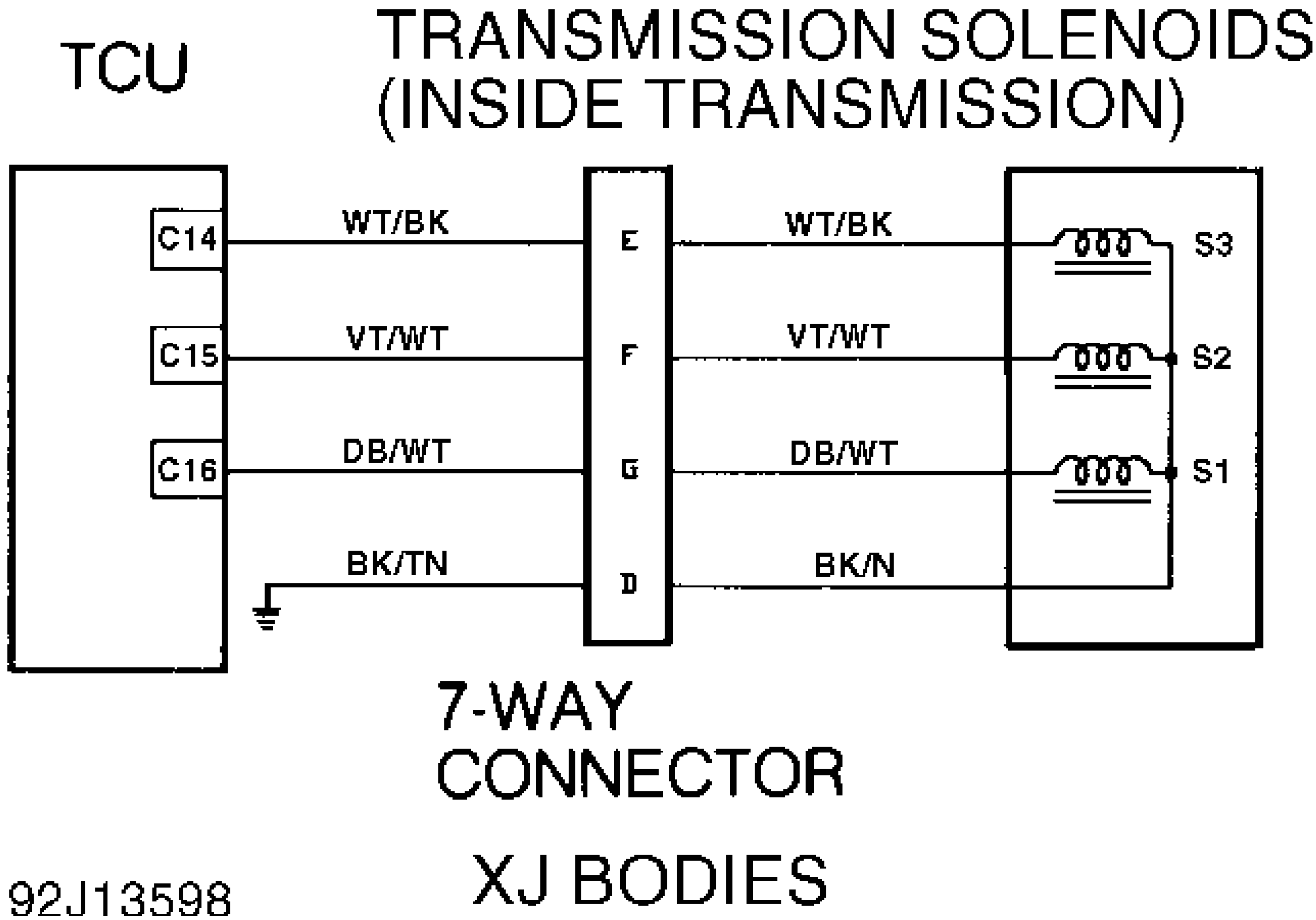


Fig. 33: Test 4C - Code 700, Schematic (Cherokee)

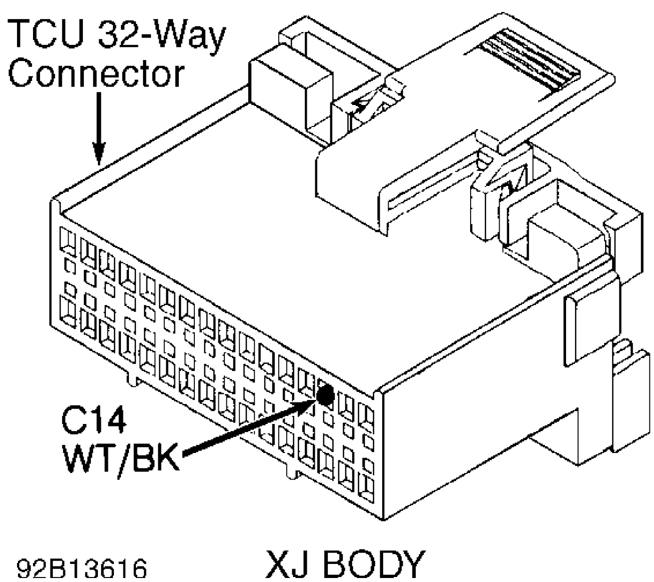


Fig. 34: Test 4C - TCU 32-Way Connector (Cavity 14, Cherokee)

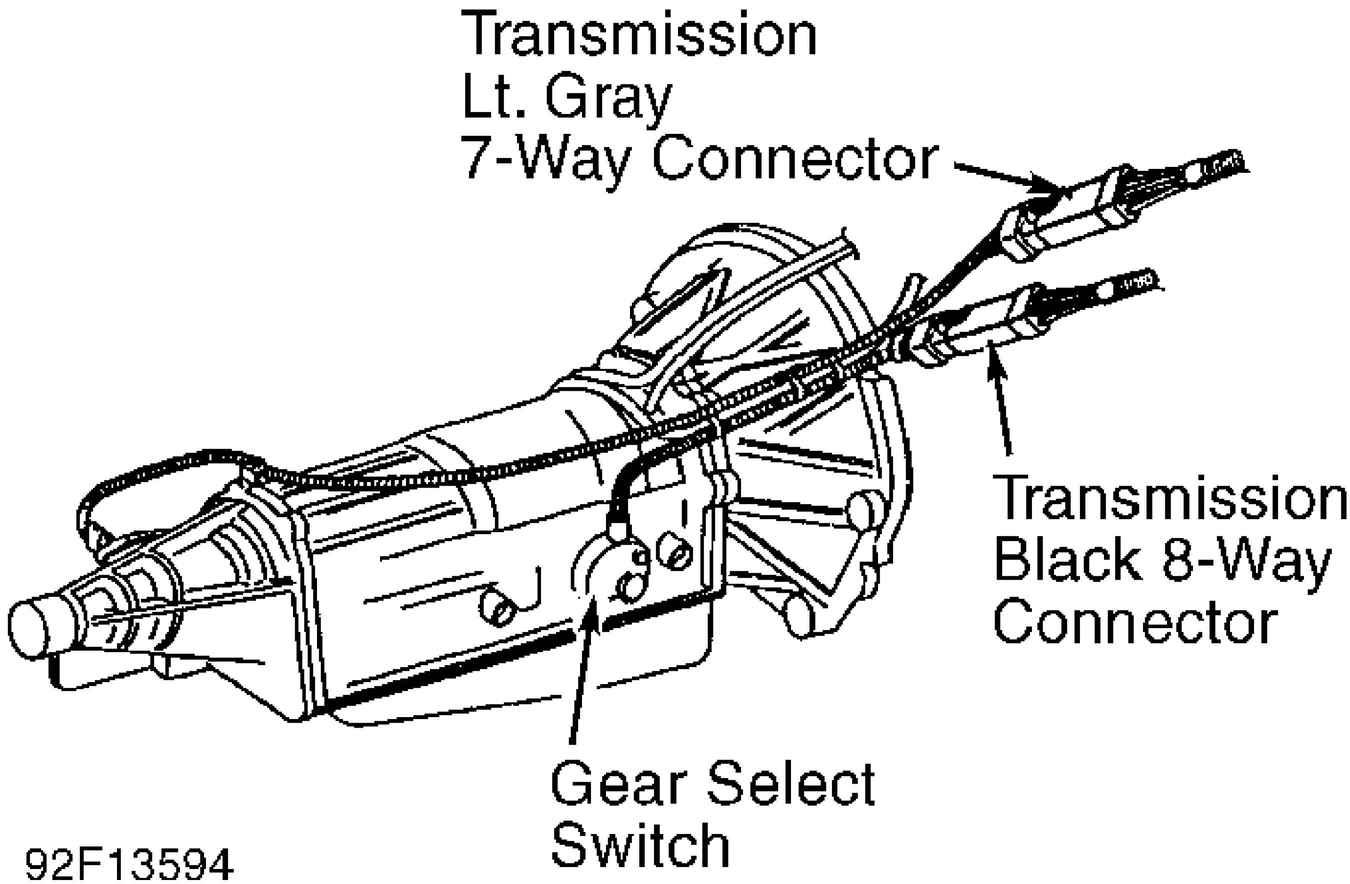
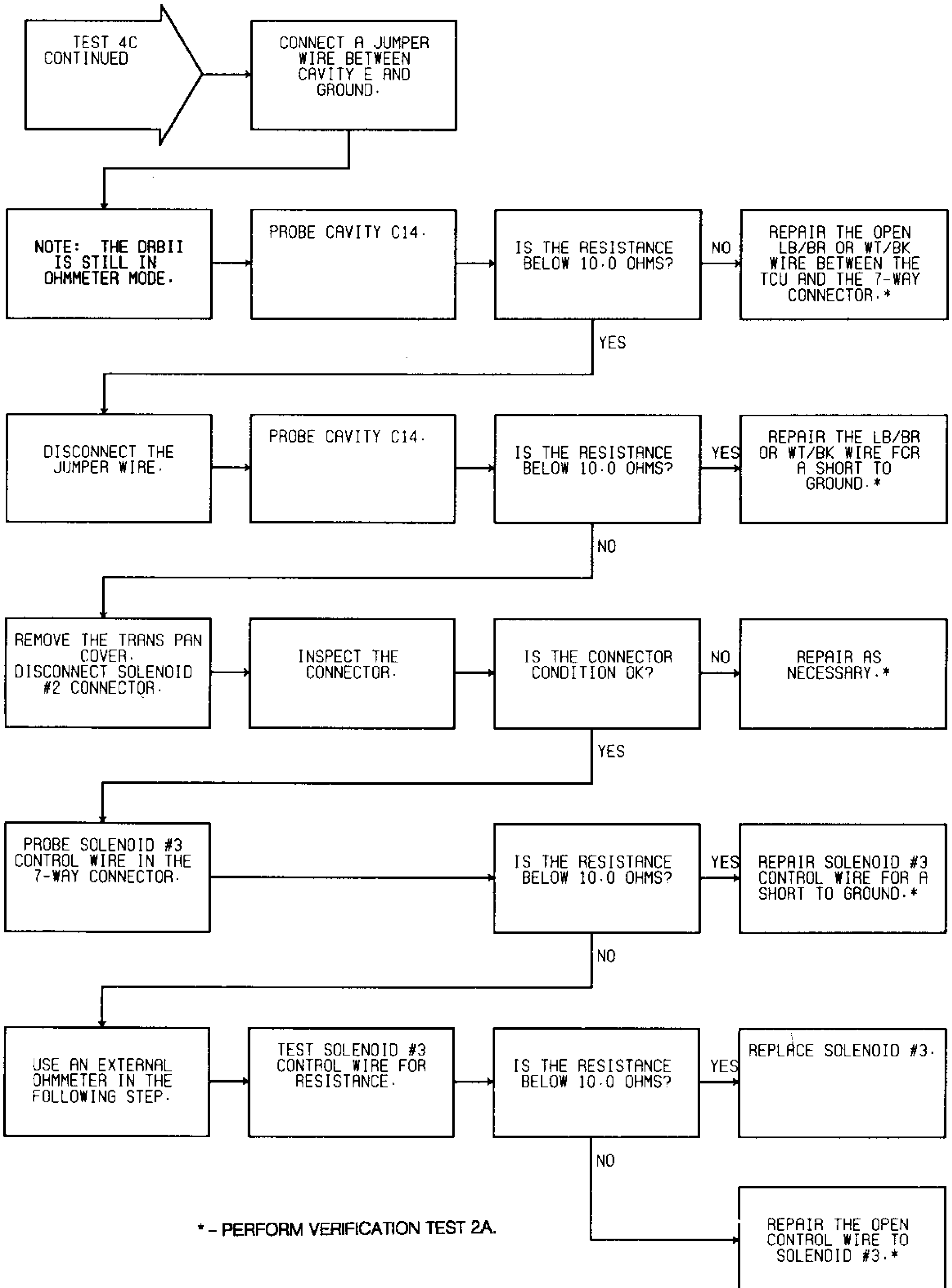


Fig. 35: Test 4C - Code 700, Location of 7-Way Connector



NOTE: See TEST 4C (1 OF 2) for wiring diagram.

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Fig. 36: Test 4C - Code 700, Flow Chart (2 of 2)

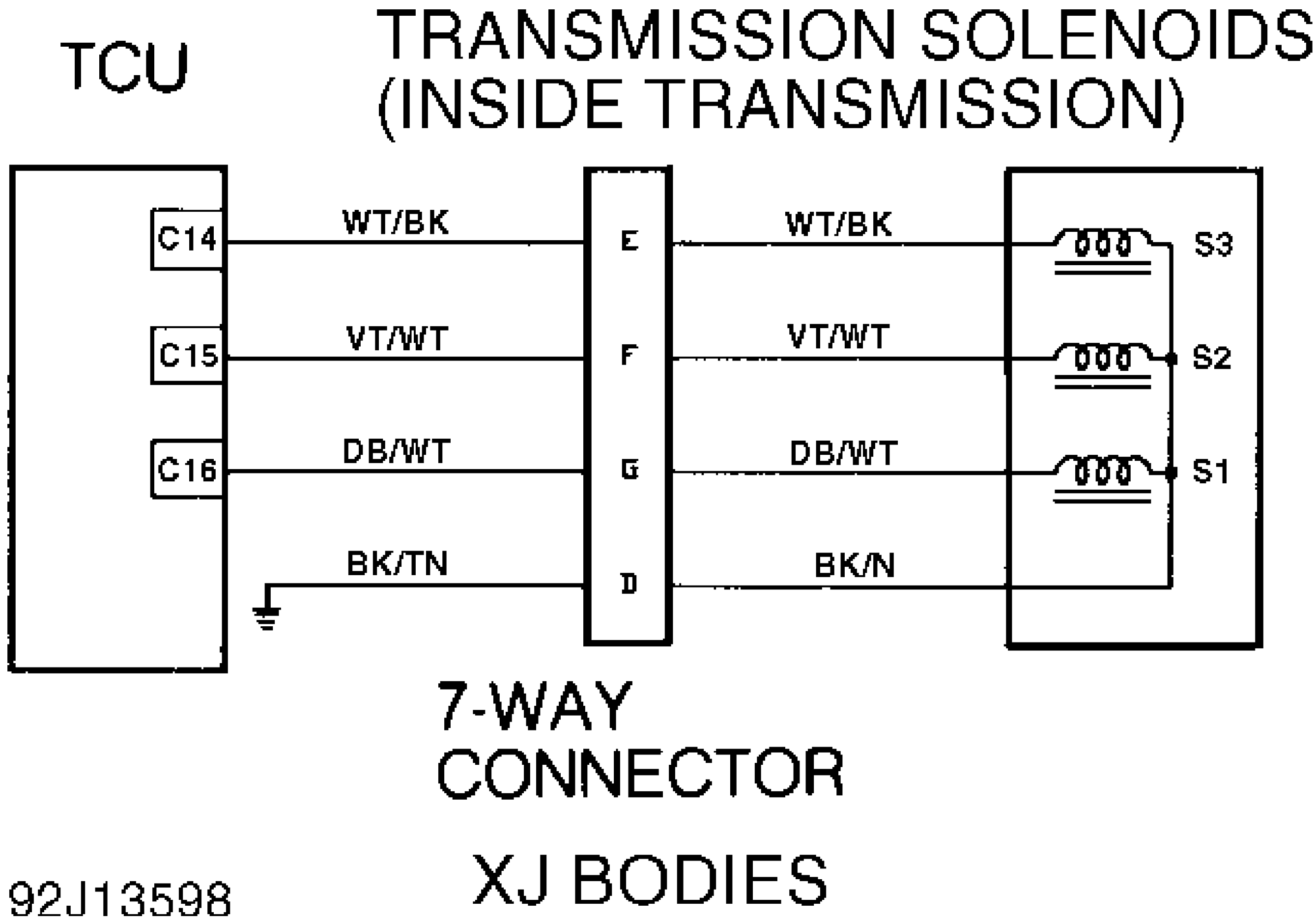


Fig. 37: Test 4B - Code 700, Schematic (Cherokee)

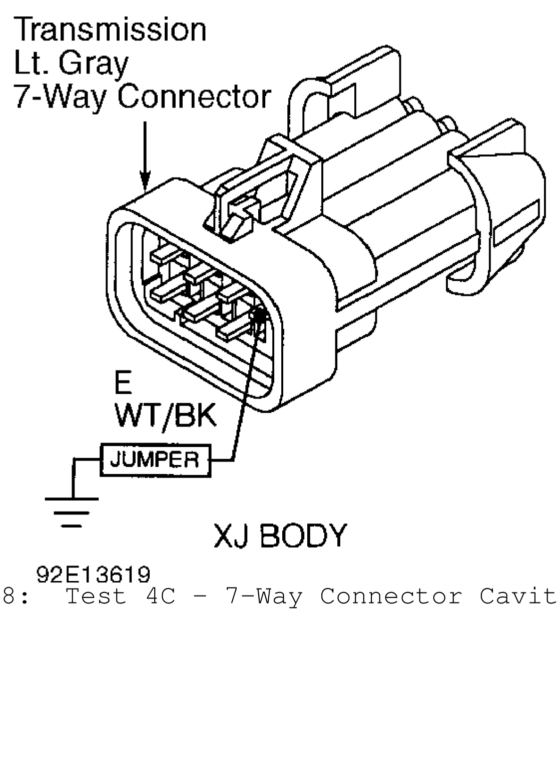


Fig. 38: Test 4C - 7-Way Connector Cavity "E" (Cherokee)

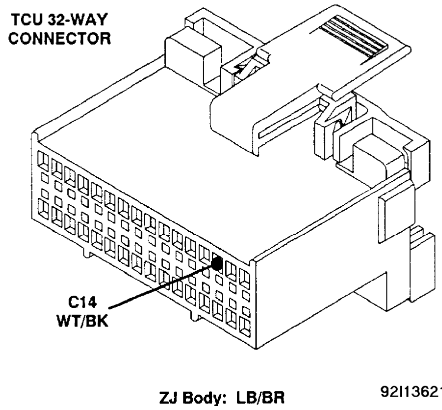


Fig. 39: Test 4C - Code 700, TCU 32-Way Connector (Cavity 14)

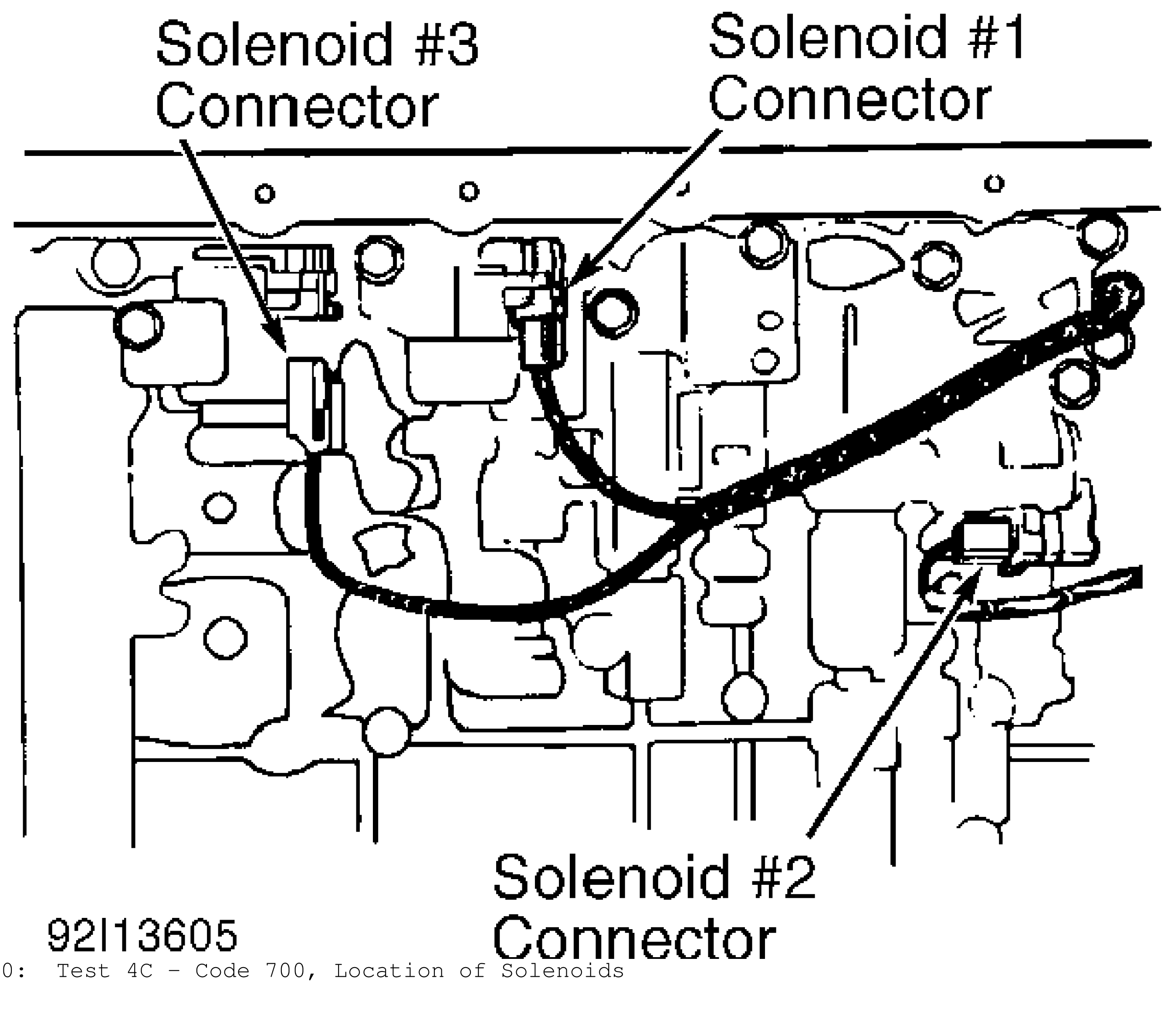
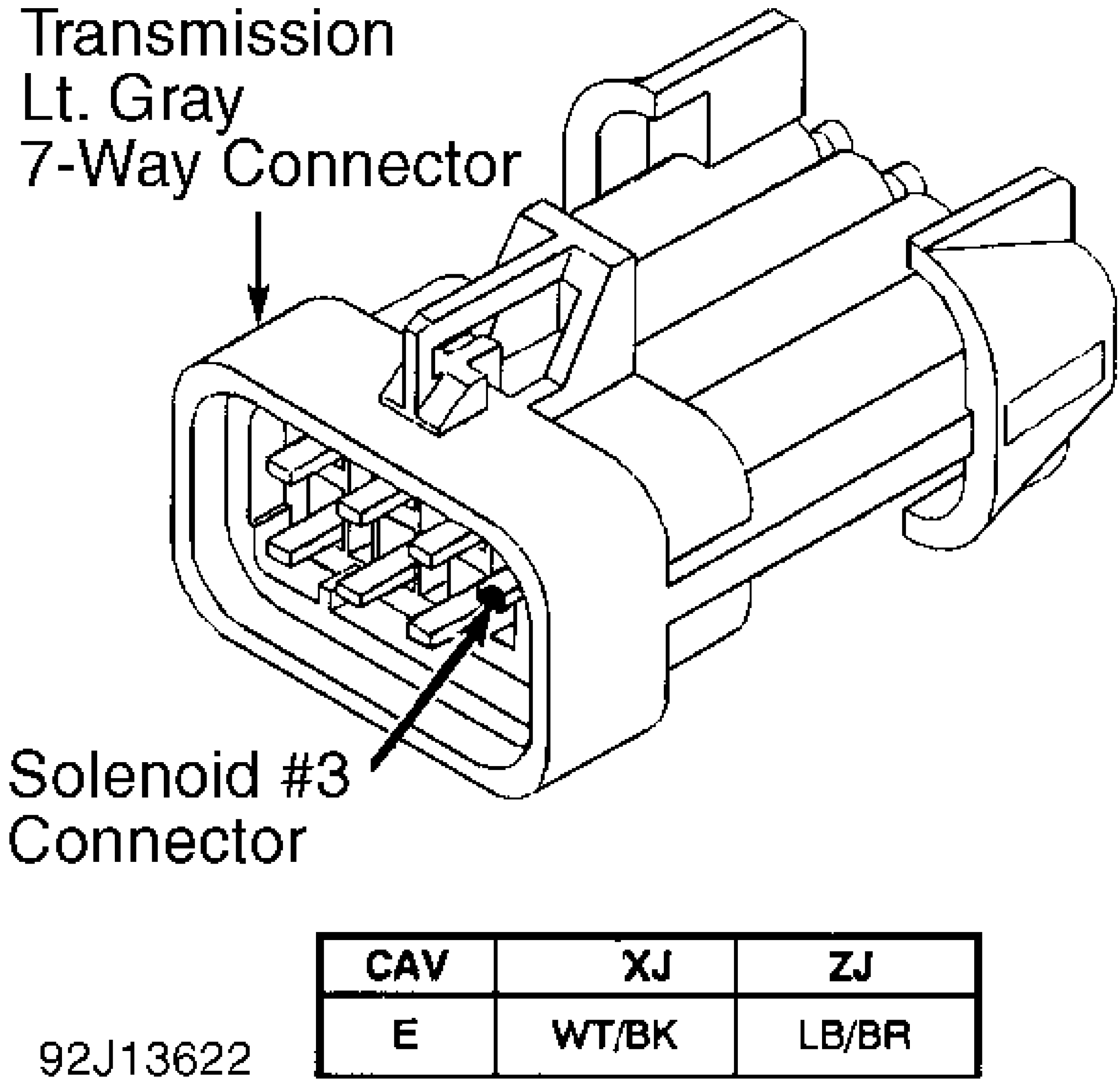


Fig. 40: Test 4C - Code 700, Location of Solenoids



CAV	XJ	ZJ
E	WT/BK	LB/BR

Fig. 41: Test 4C - Code 700, Solenoid No. 1 Wire (Cavity "E")

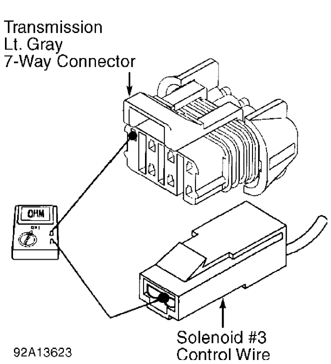


Fig. 42: Test 4C - Code 700, Testing S3 Control Wire

TEST 5A - CODE 702 - SPEED SENSOR CIRCUIT

NOTE: Perform TEST 1A - VERIFICATION OF THE COMPLAINT before proceeding.

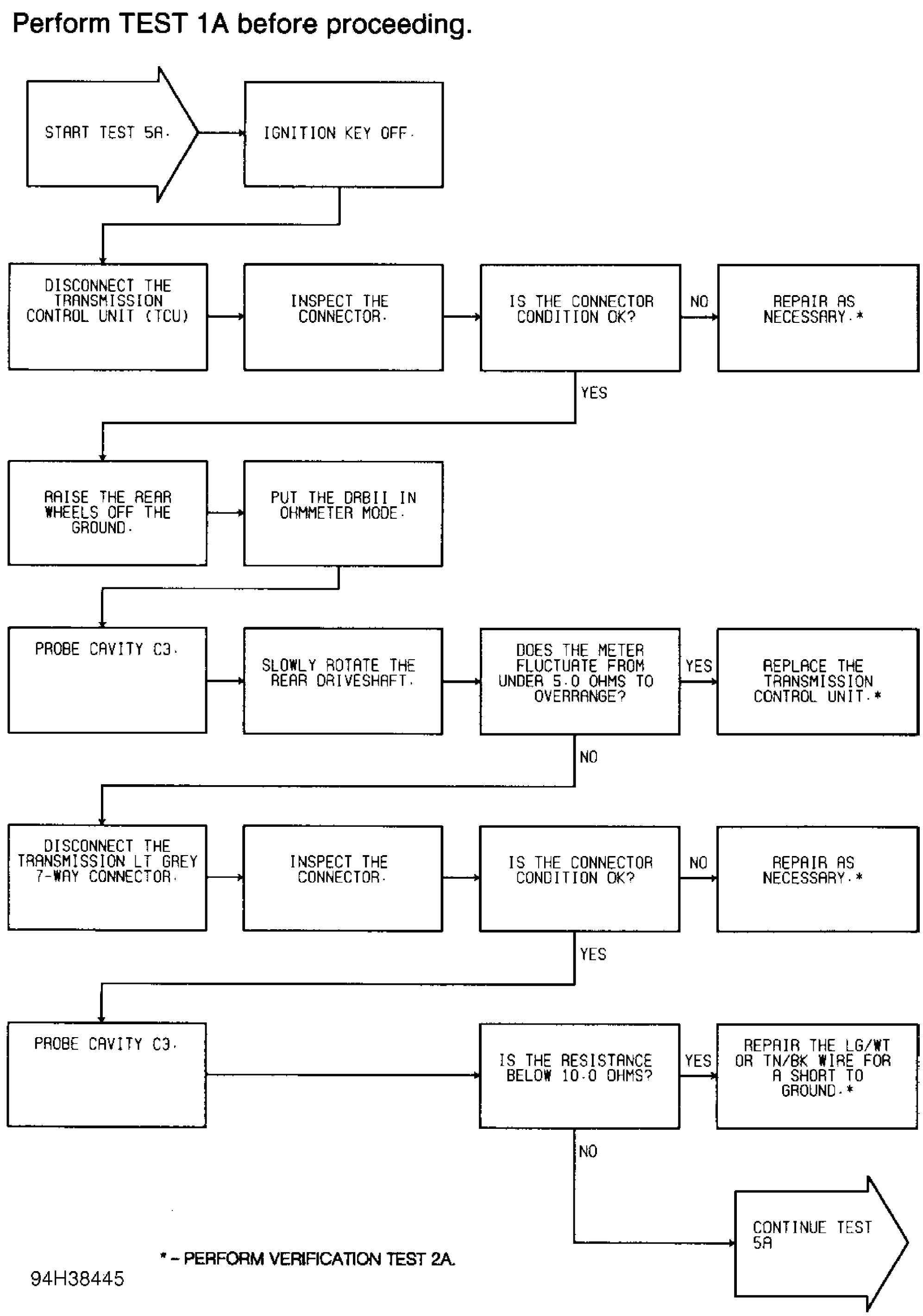


Fig. 43: Test 5A - Code 702, Flow Chart (1 of 2)

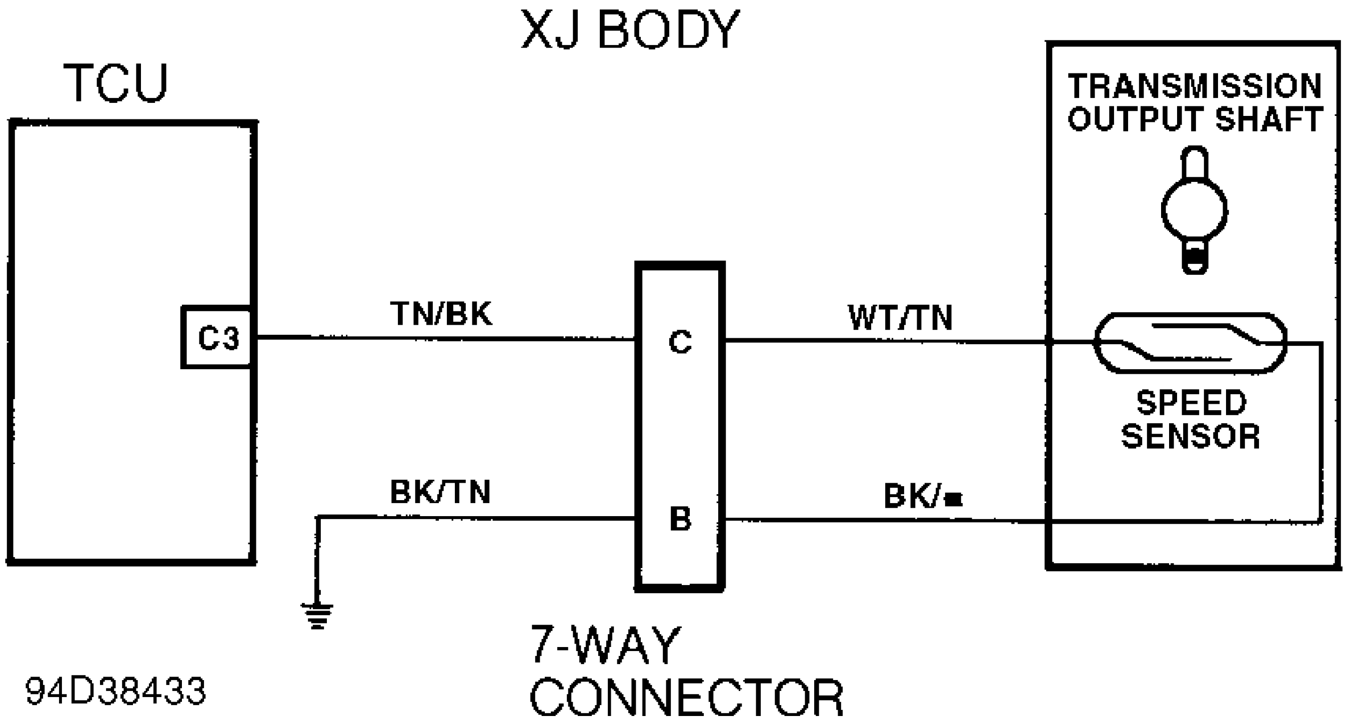


Fig. 44: Test 5A - Code 702, Speed Sensor Schematic (Cherokee)

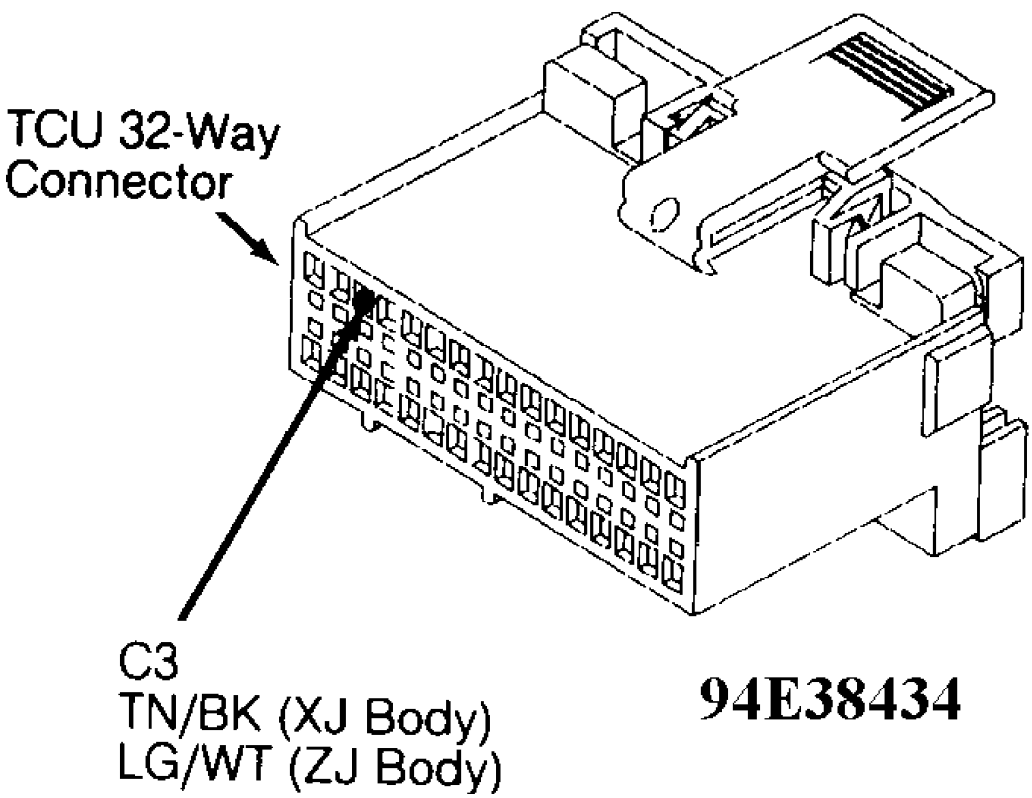


Fig. 45: Test 5A - Code 702, TCU 32-Way Connector (Cavity 3)

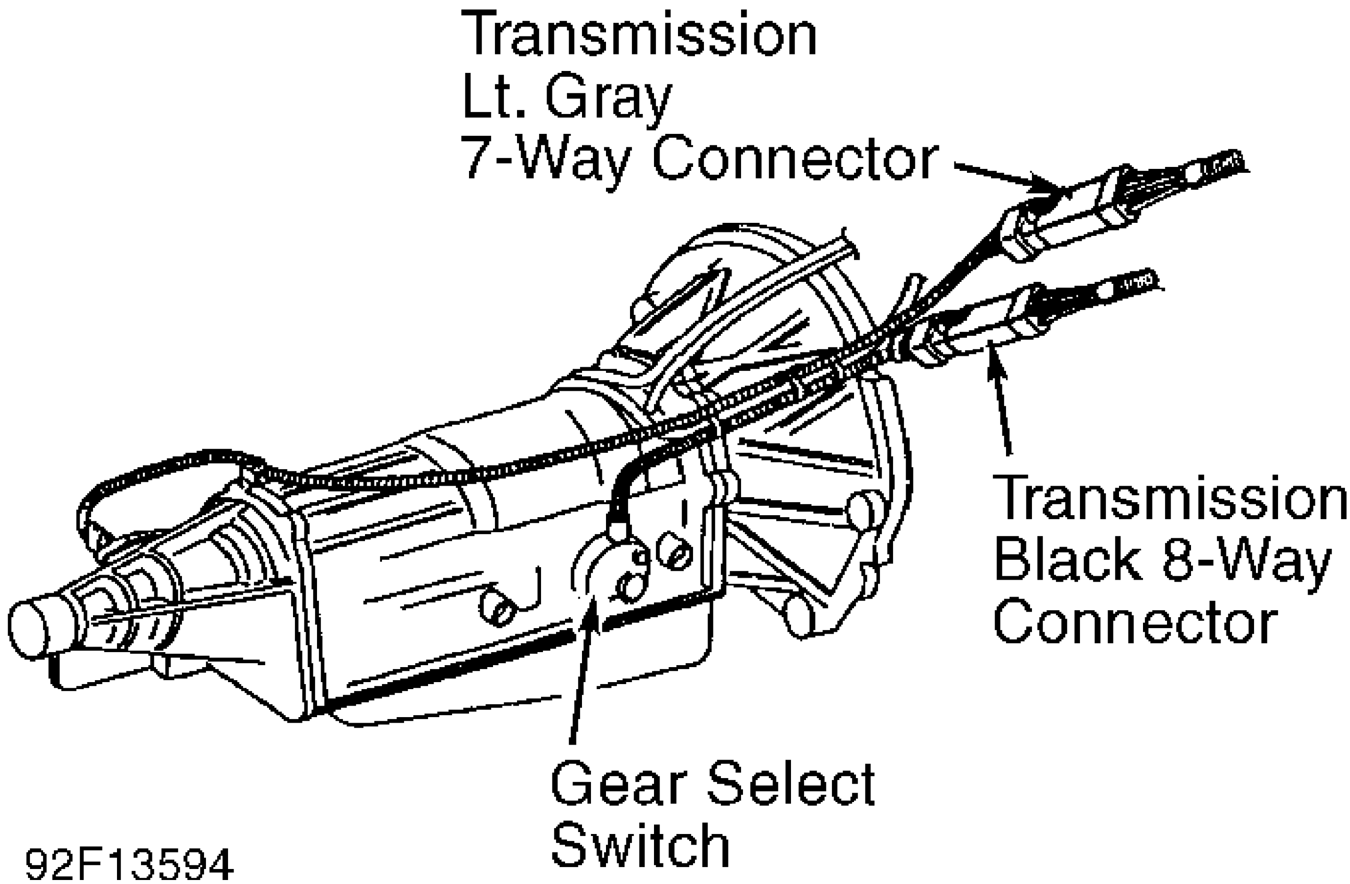


Fig. 46: Test 5A - Code 702, Location of 7-Way Connector

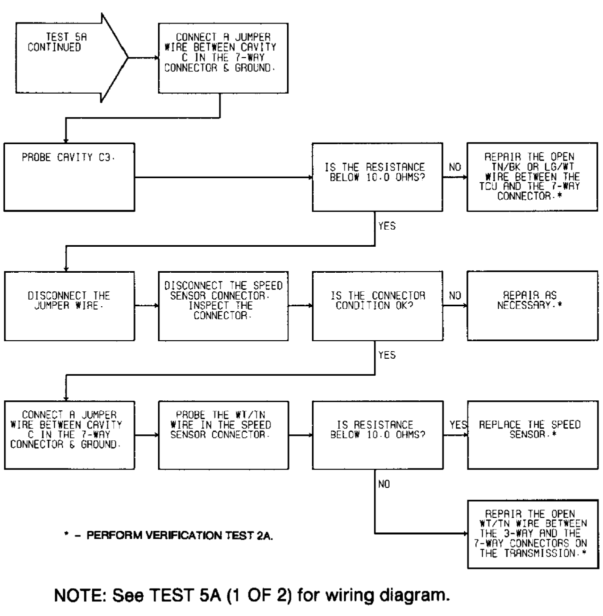


Fig. 47: Test 5A - Code 702, Flow Chart (2 of 2)

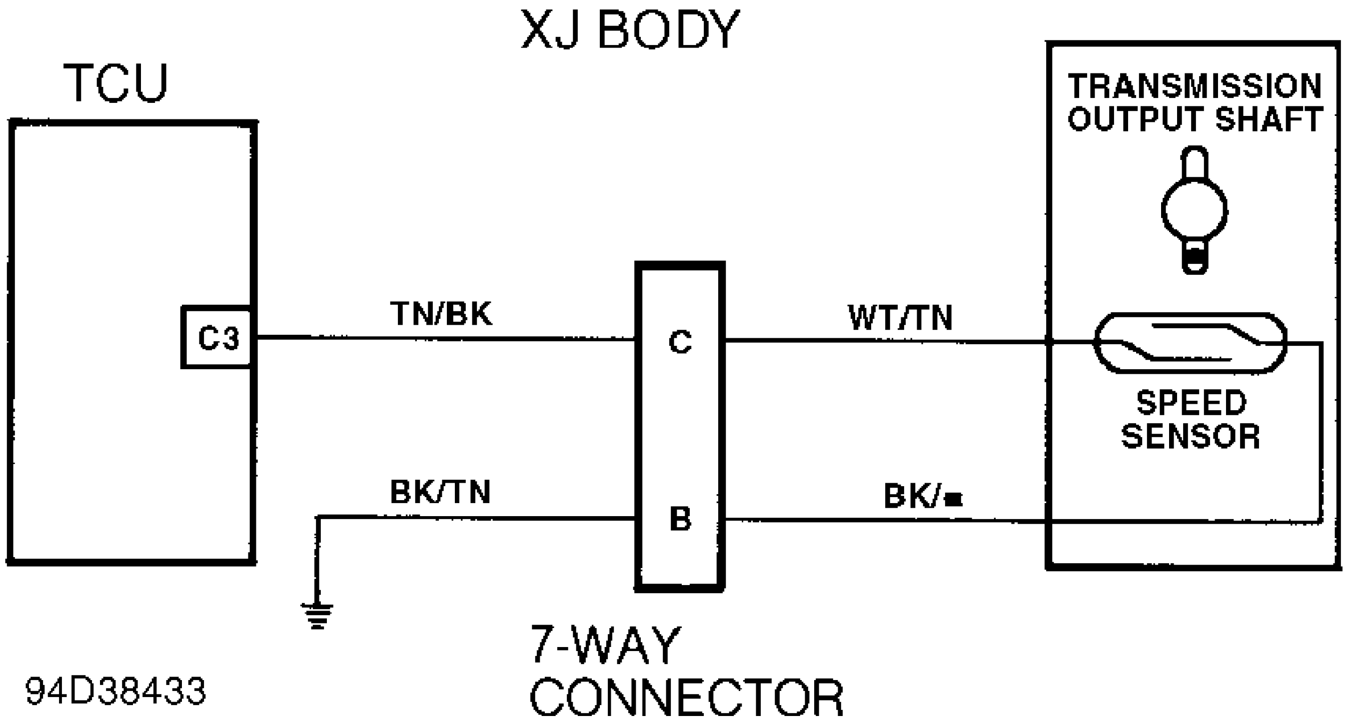


Fig. 48: Test 5A - Code 702, Speed Sensor Schematic (Cherokee)

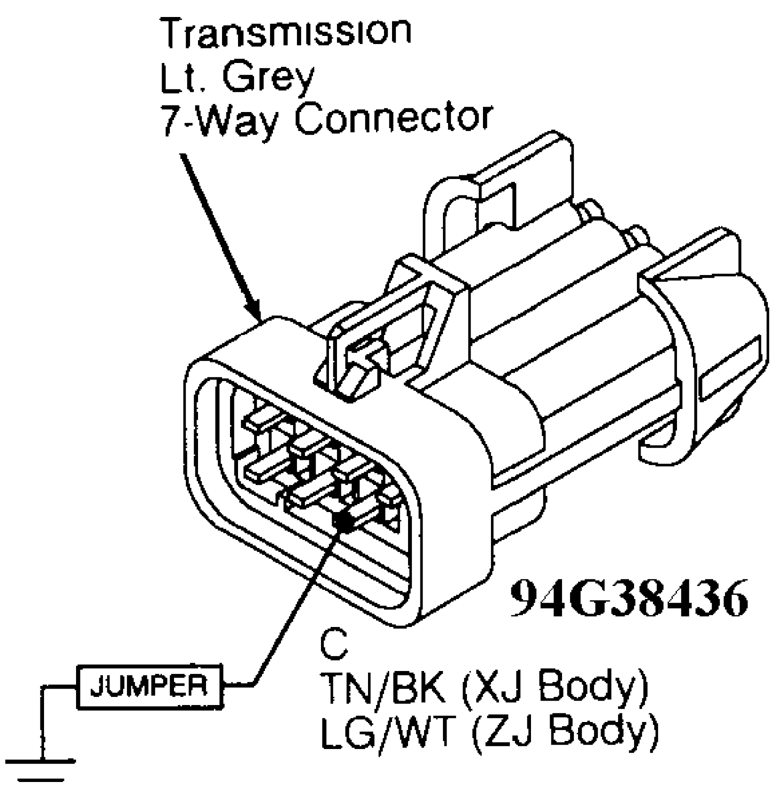


Fig. 49: Test 5A - Transmission 7-Way Connector (Male Side)

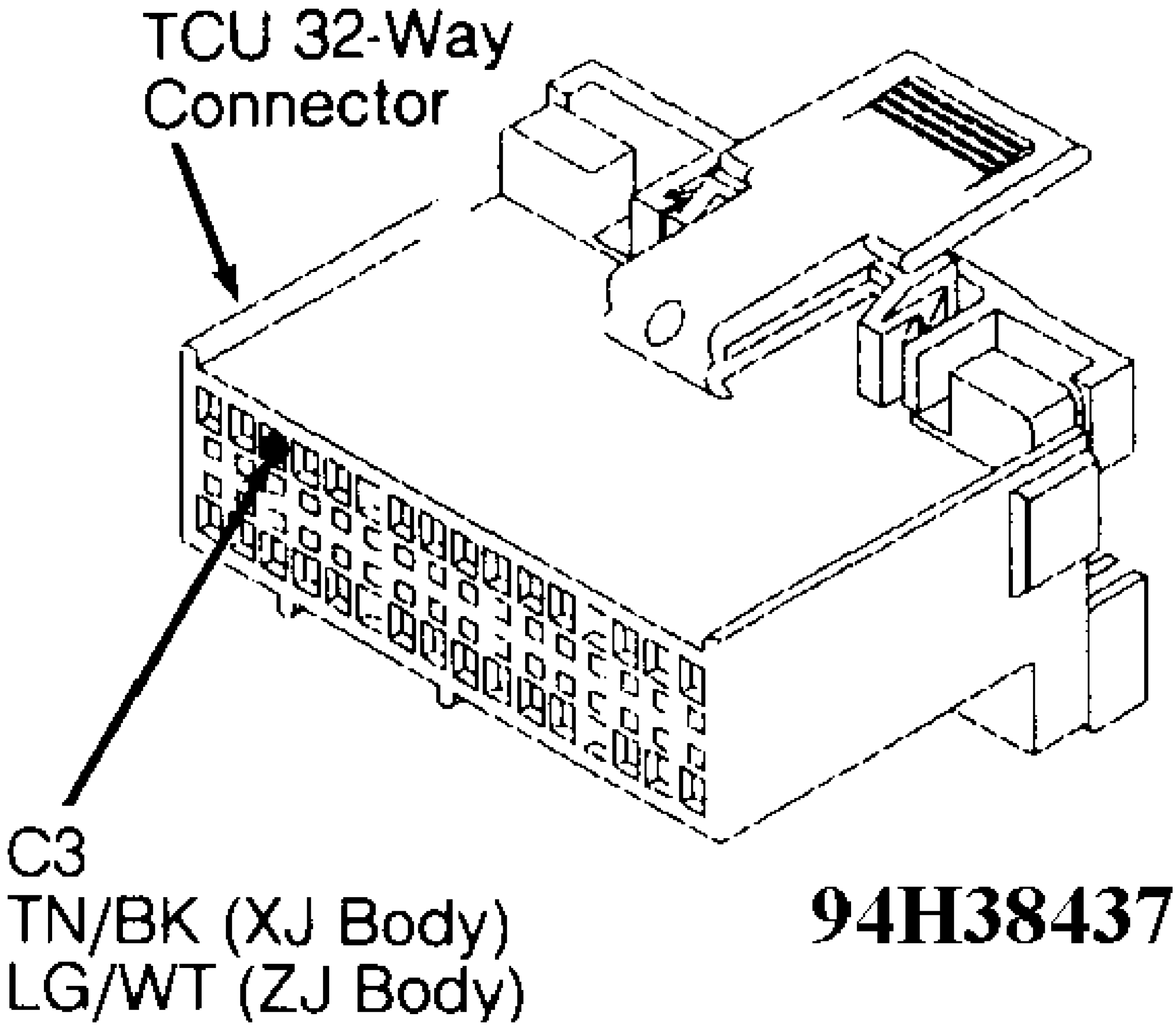


Fig. 50: Test 5A - Code 702, TCU 32-Way Connector (Cavity 3)

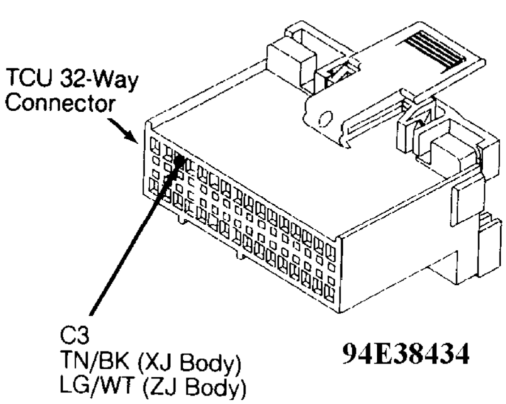


Fig. 51: Test 5A - Code 702, TCU 32-Way Connector (Cavity 3)

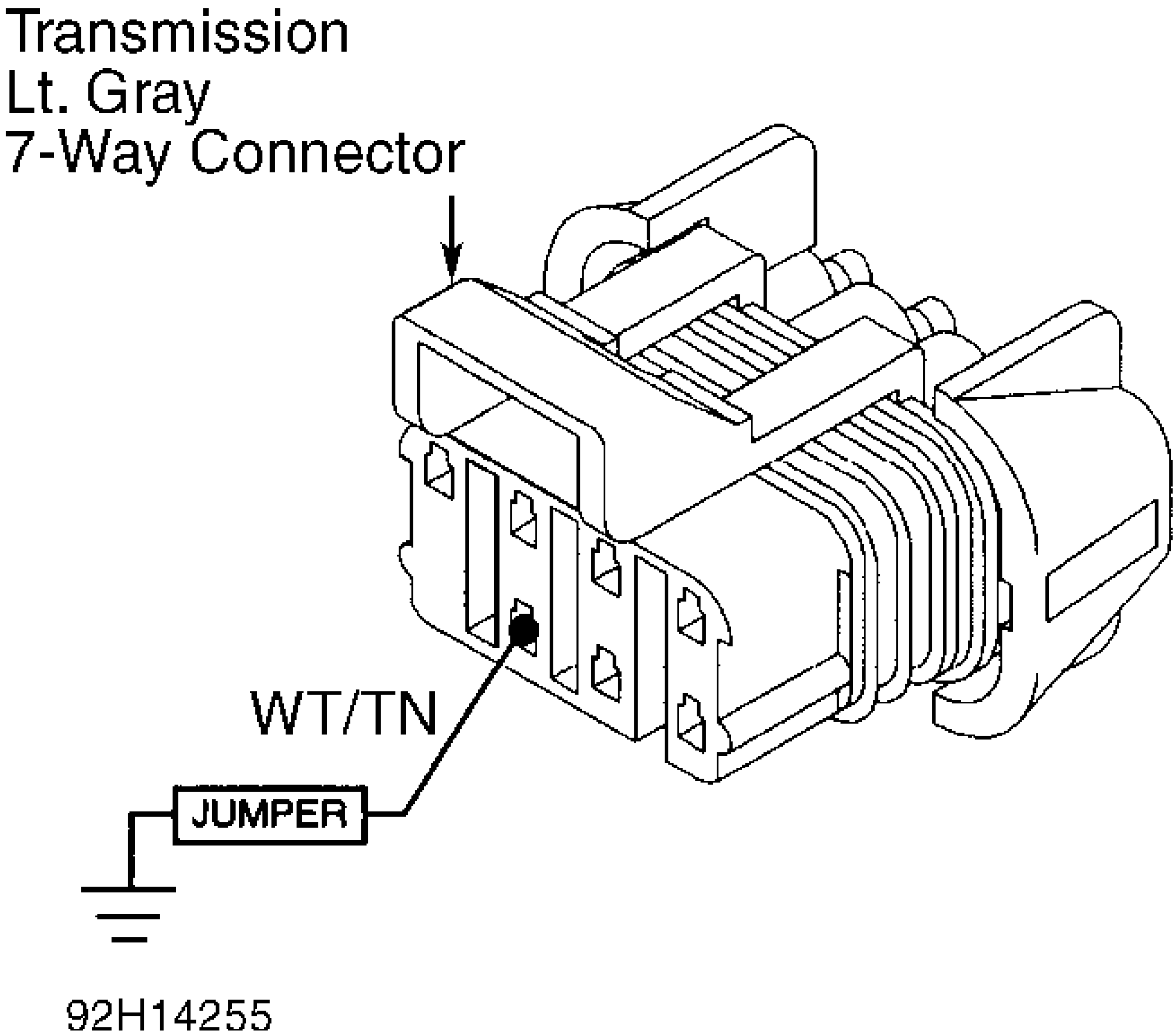


Fig. 52: Test 5A - Transmission 7-Way Connector (Female Side)

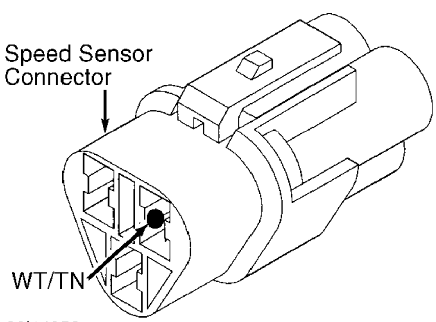


Fig. 53: Test 5A - Code 702, View of Speed Sensor Connector

TEST 6A - CODE 703 - GEAR SELECT SWITCH CIRCUIT

Perform TEST 1A before proceeding.

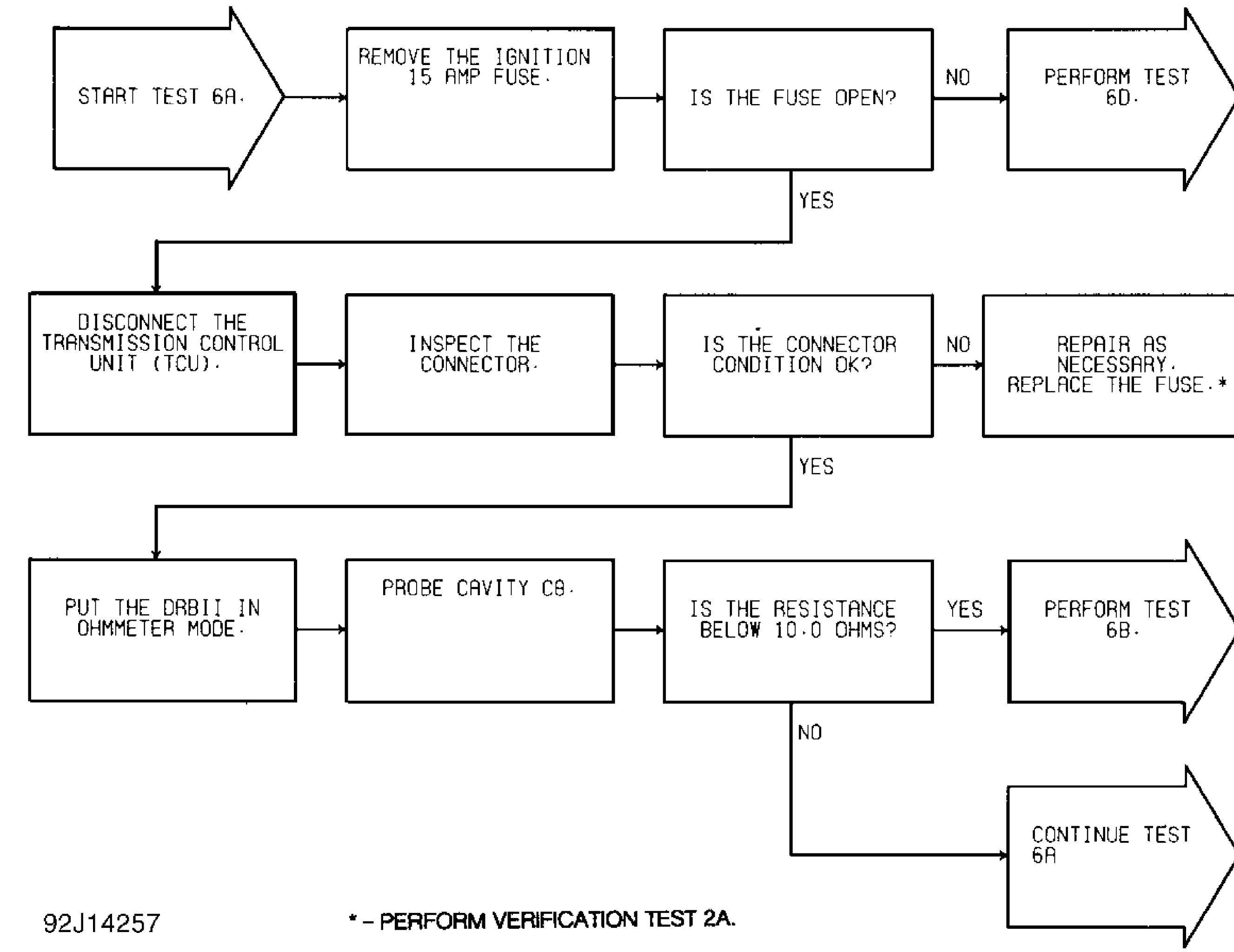


Fig. 54: Test 6A - Code 703, Flow Chart (1 of 2)

MJ and XJ Bodies

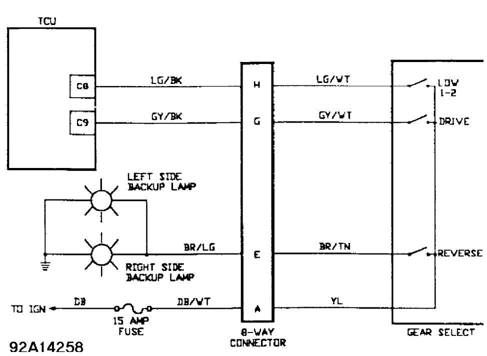


Fig. 55: Test 6A - Gear Select Switch Schematic (Cherokee)

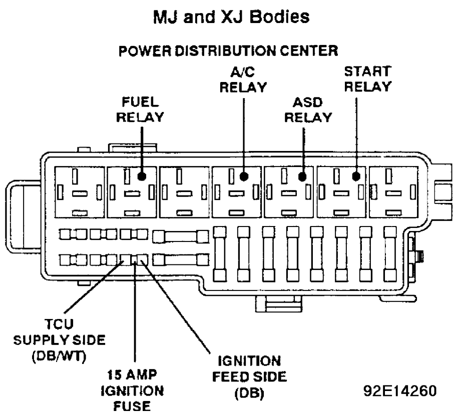


Fig. 56: Test 6A - Location of Gear Select Switch Fuse (Cherokee)

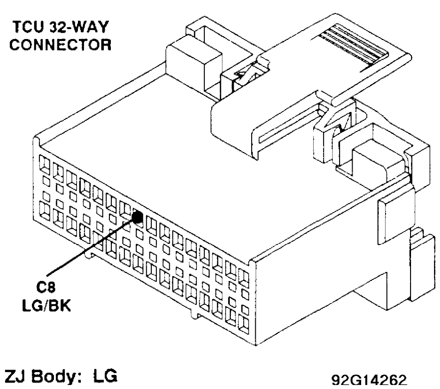


Fig. 57: Test 6A - TCU 32-Way Connector (Cavity 8)

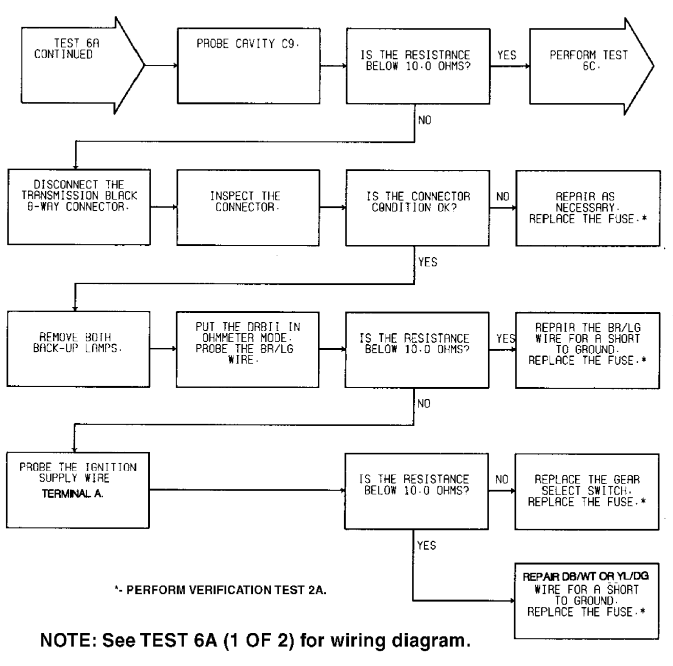


Fig. 58: Test 6A - Code 703, Flow Chart (2 of 2)

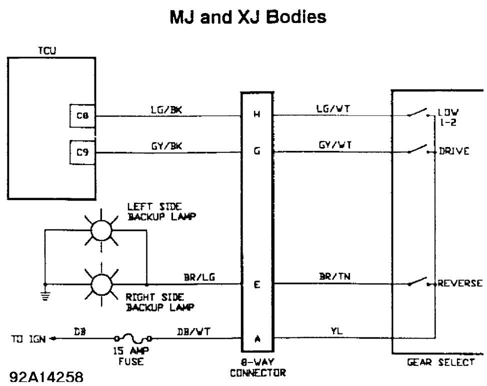


Fig. 59: Test 6A - Gear Select Switch Schematic (Cherokee)

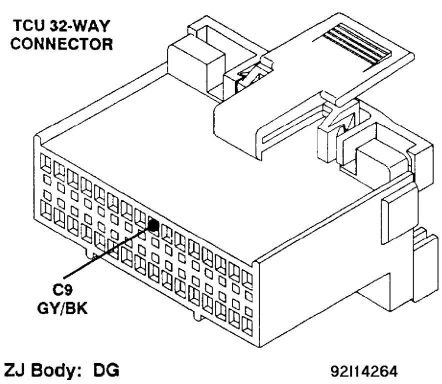


Fig. 60: Test 6A - Code 703, TCU 32-Way Connector (Cavity 9)

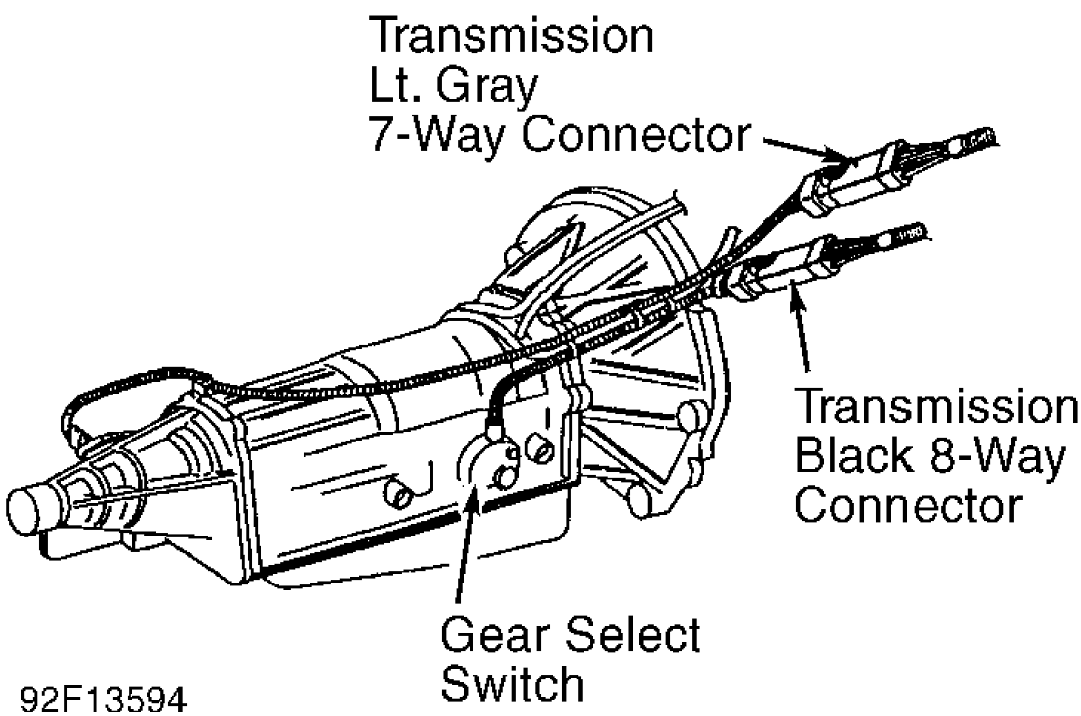


Fig. 61: Test 6A - Code 703, Location of Gear Select Switch

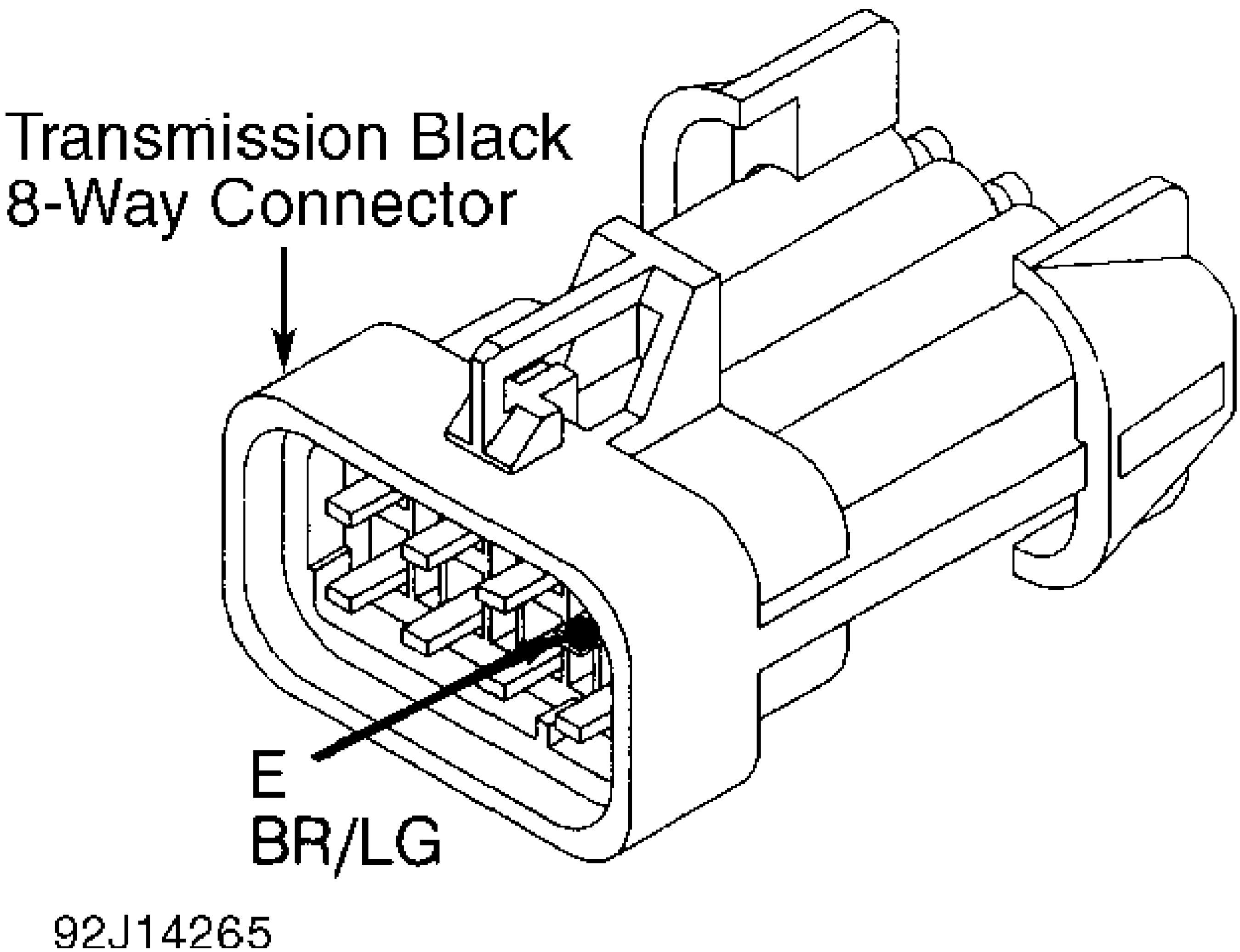


Fig. 62: Test 6A - Code 703, 8-Way Black Connector Cavity "E"

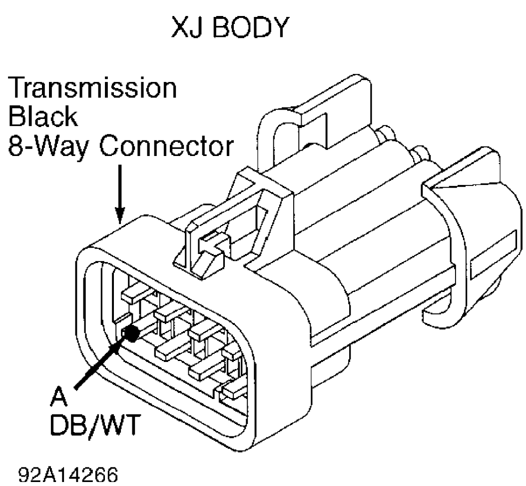


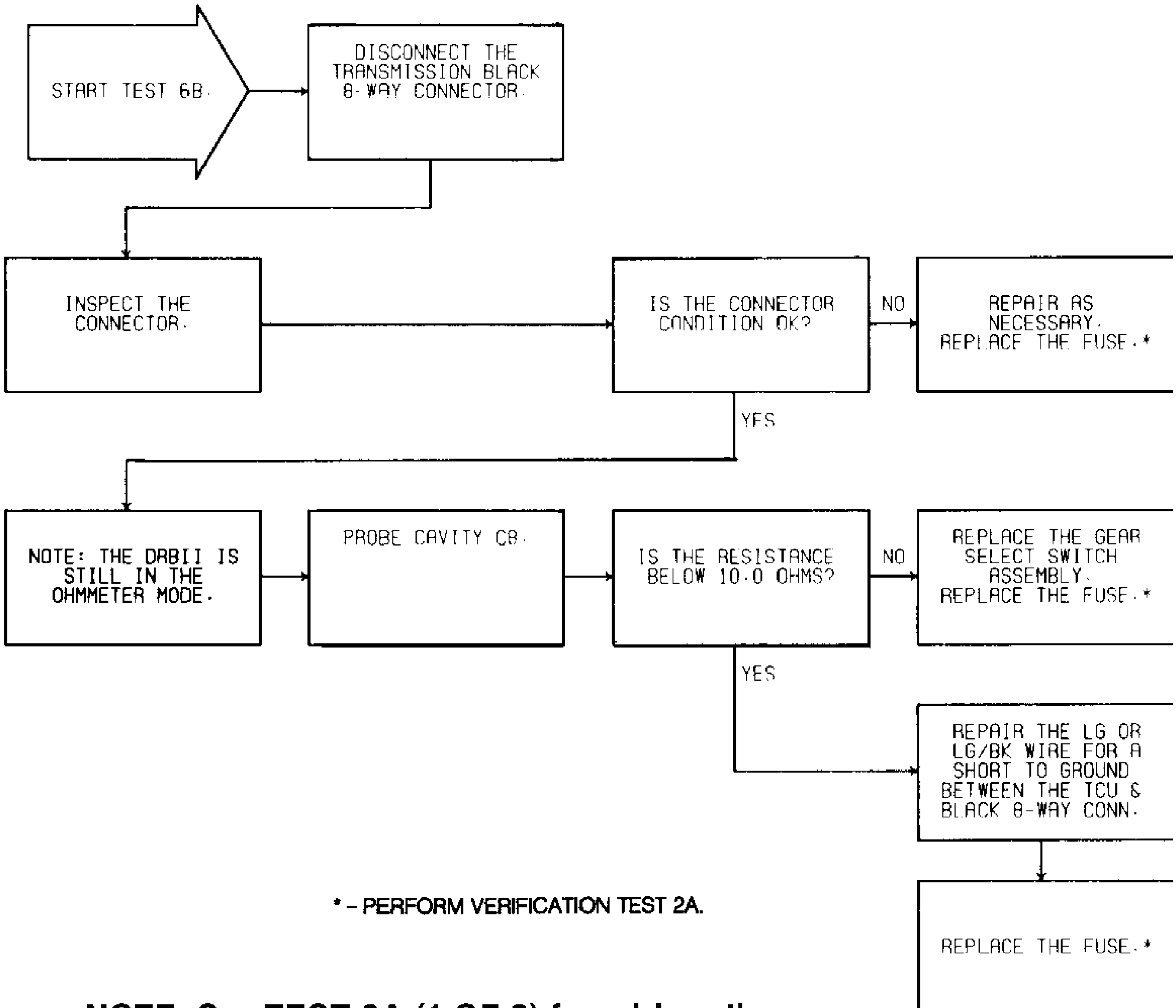
Fig. 63: Test 6A - 8-Way Black Connector Cavity "A" (Cherokee)

TEST 6B - CODE 703 - GEAR SELECT SWITCH CIRCUIT

NOTE: Perform TEST 6A - CODE 703 - GEAR SELECT SWITCH CIRCUIT

before proceeding.

Perform TEST 6A before proceeding.



NOTE: See TEST 6A (1 OF 2) for wiring diagram.

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Fig. 64: Test 6B - Code 703, Flow Chart

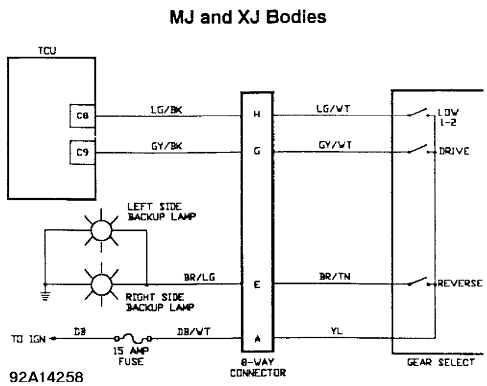


Fig. 65: Test 6B - Gear Select Switch Schematic (Cherokee)

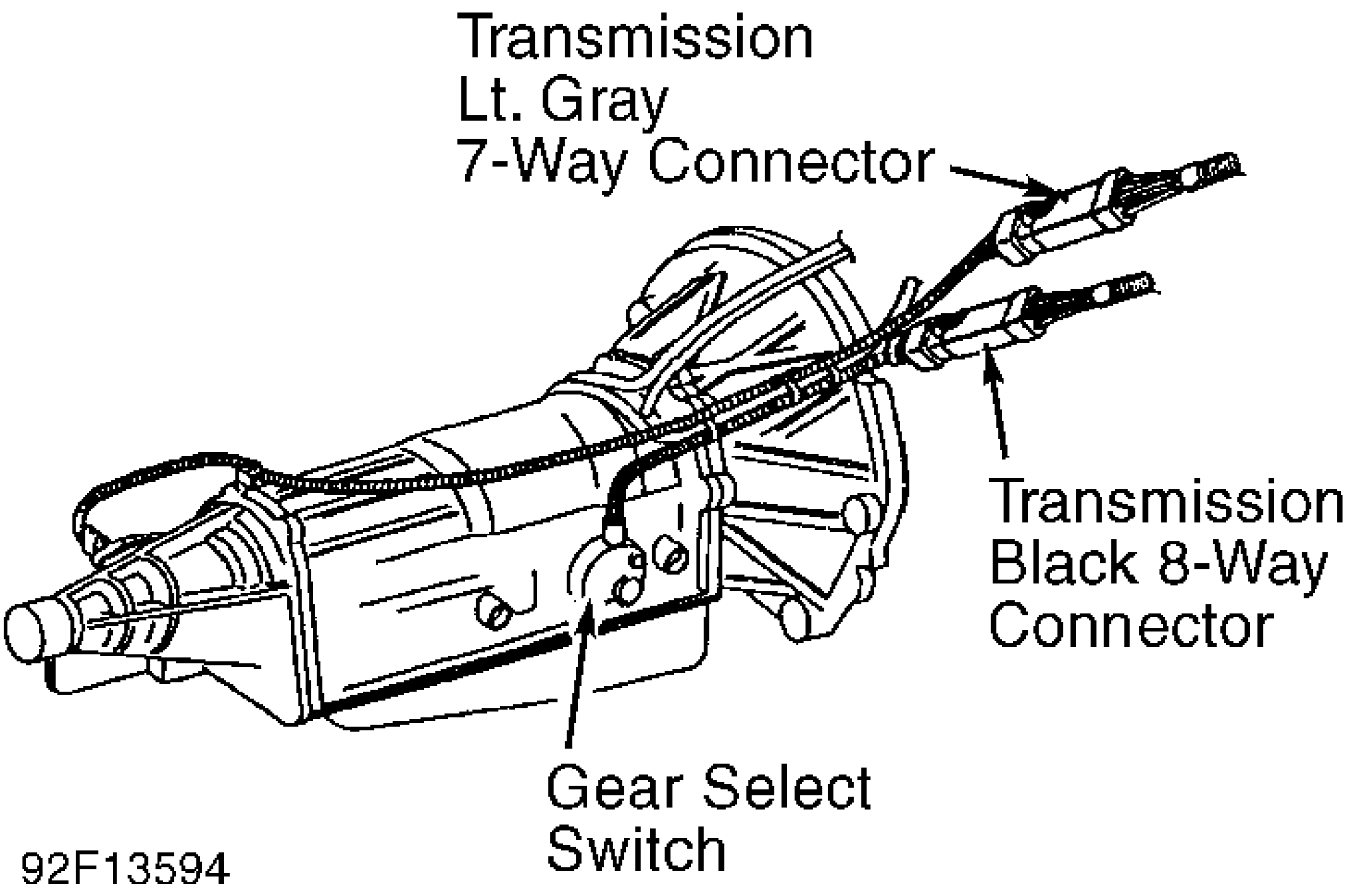


Fig. 66: Test 6B - Code 703, Location of Gear Select Switch

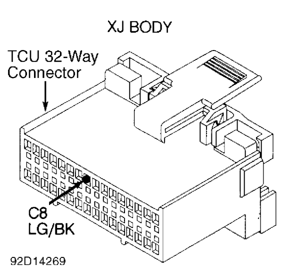


Fig. 67: Test 6B - TCU 32-Way Connector (Cavity 8, Cherokee)

TEST 6C - CODE 703 - GEAR SELECT SWITCH CIRCUIT

NOTE: Perform TEST 6A - CODE 703 - GEAR SELECT SWITCH CIRCUIT before proceeding.

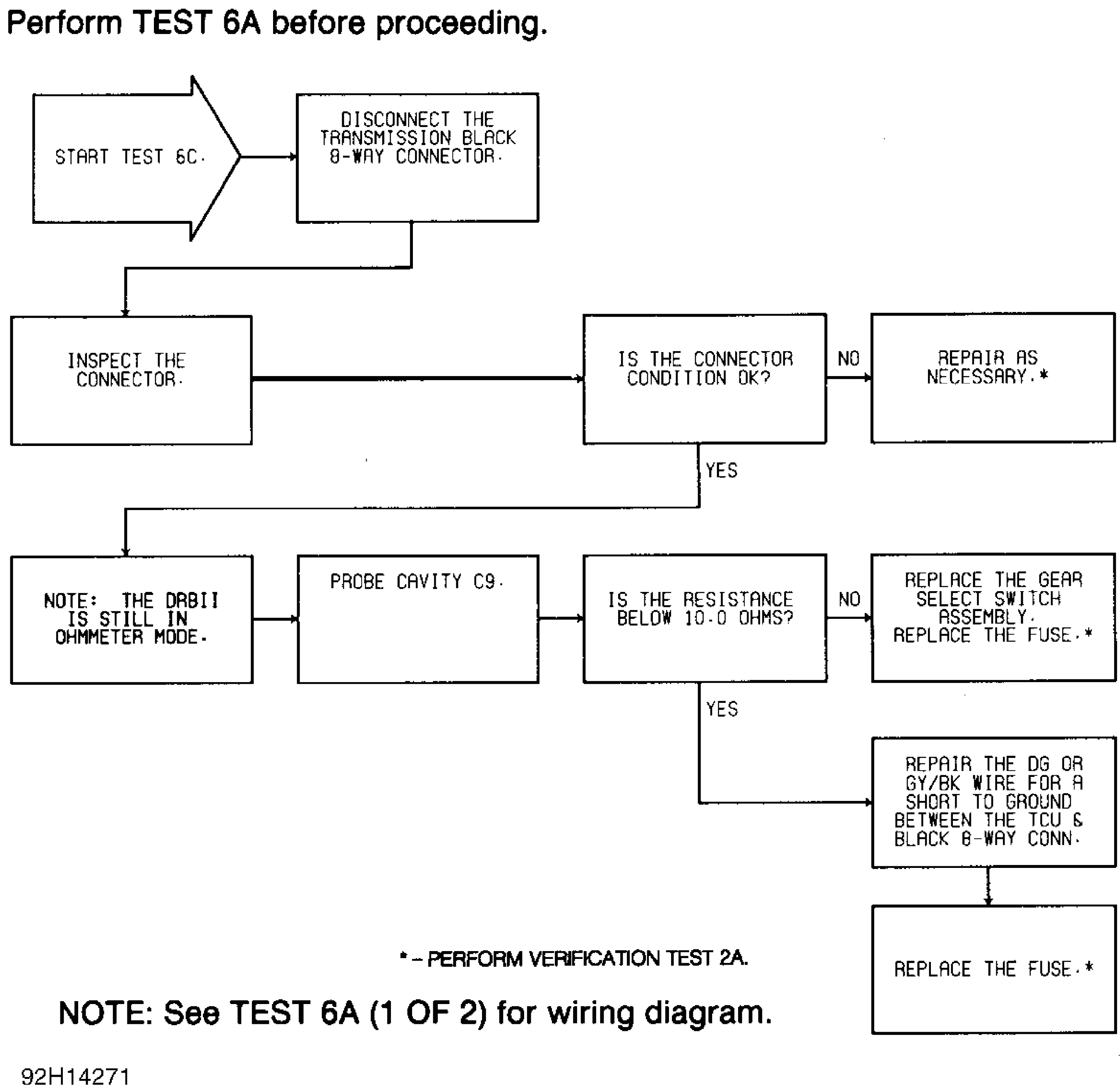


Fig. 68: Test 6C - Code 703, Flow Chart

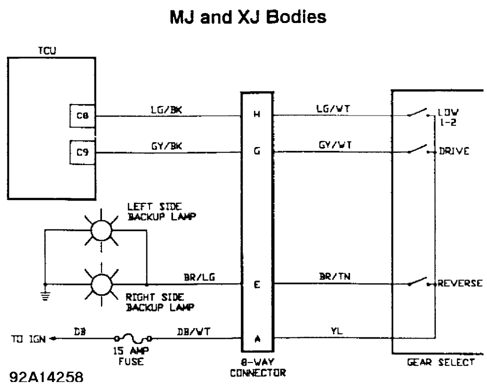


Fig. 69: Test 6C - Gear Select Switch Schematic (Cherokee)

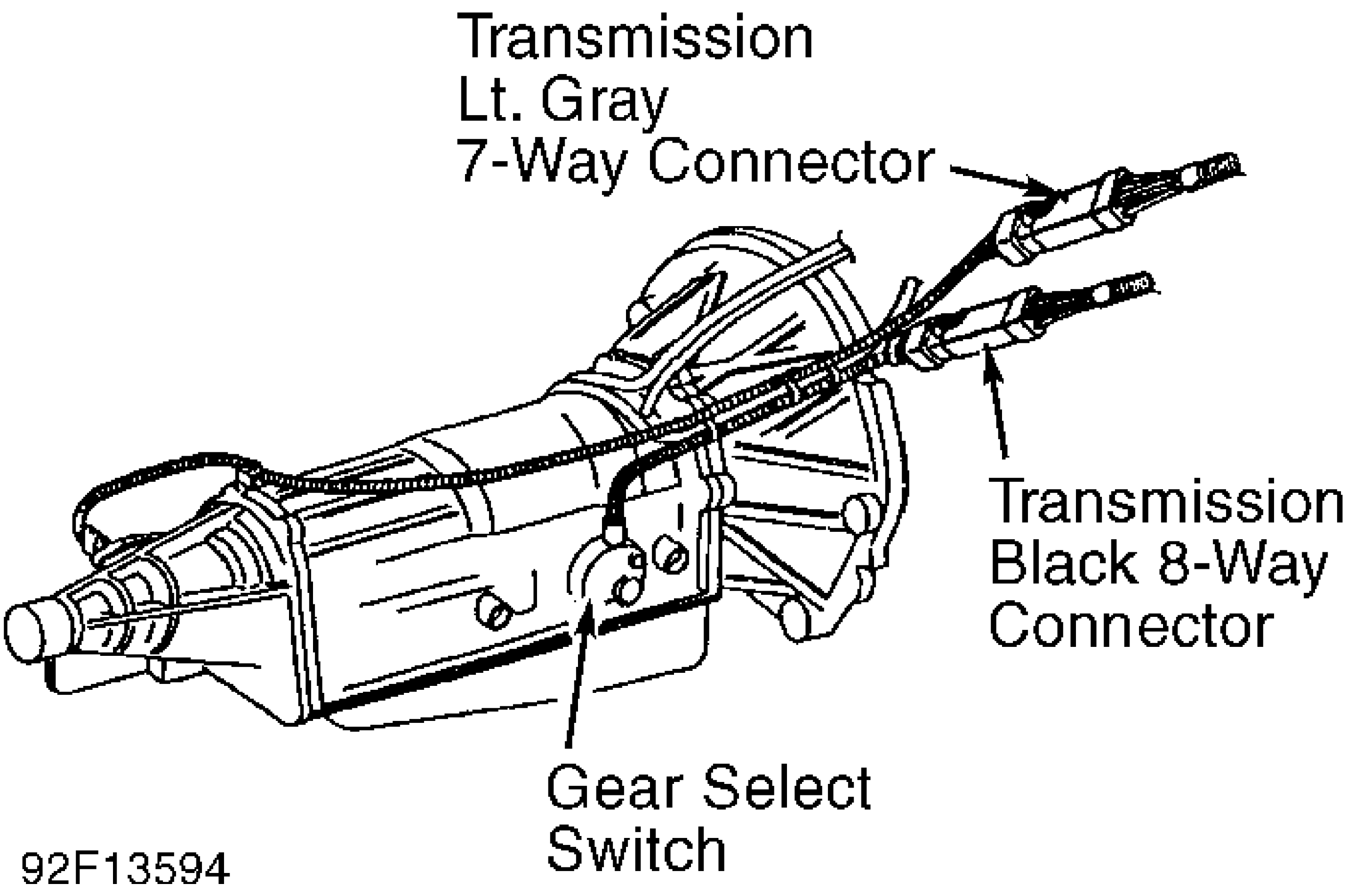


Fig. 70: Test 6C - Code 703, Location of Gear Select Switch

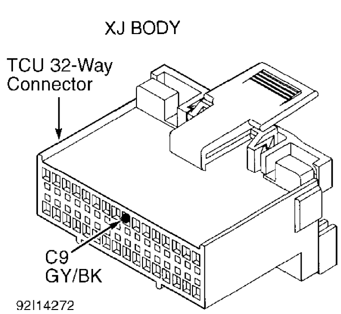


Fig. 71: Test 6C - TCU 32-Way Connector (Cavity 9, Cherokee)

TEST 6D - CODE 703 - GEAR SELECT SWITCH CIRCUIT

NOTE: Perform TEST 6A - CODE 703 - GEAR SELECT SWITCH CIRCUIT before proceeding.

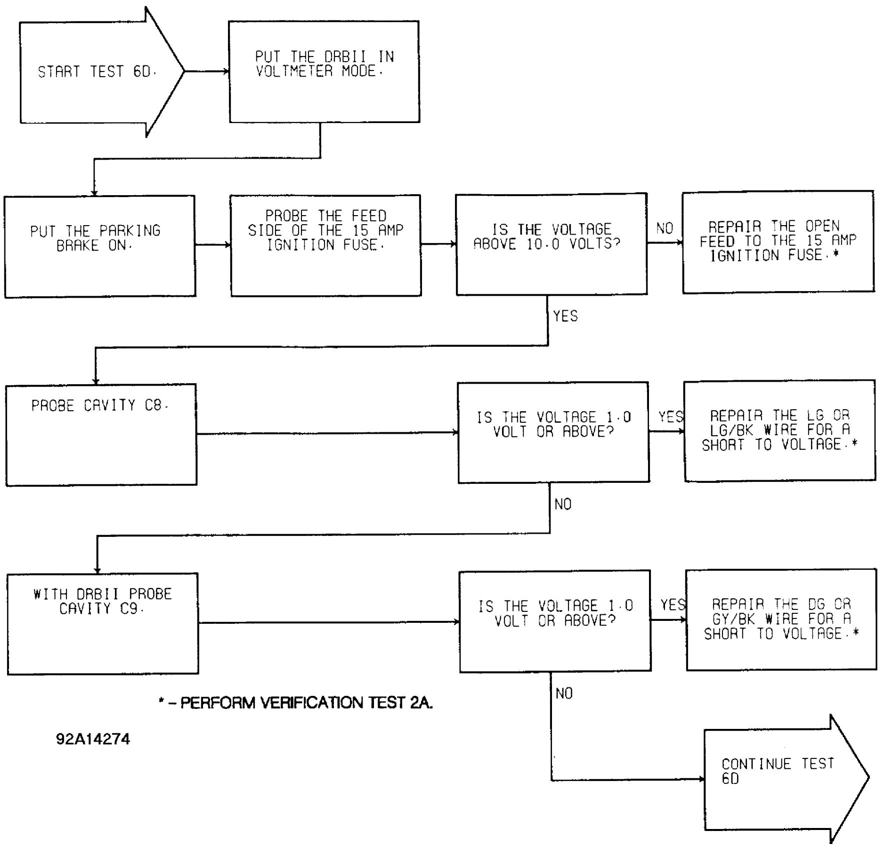


Fig. 72: Test 6D - Code 703, Flow Chart (1 of 3)

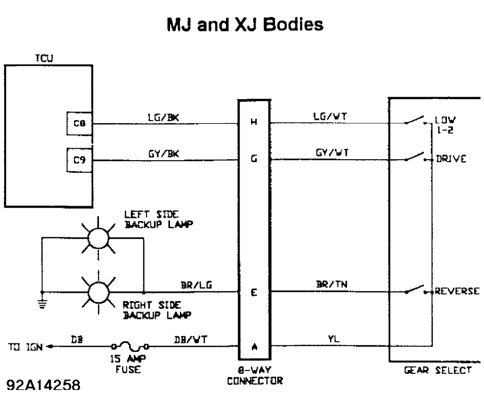


Fig. 73: Test 6D - Gear Select Switch Schematic (Cherokee)

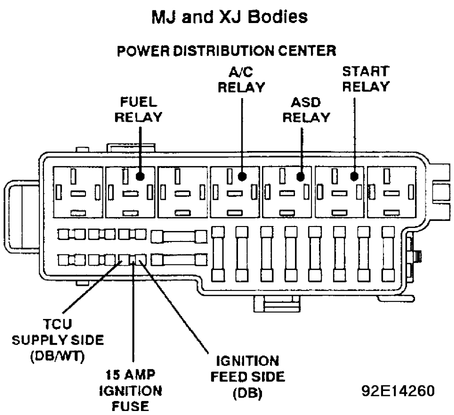


Fig. 74: Test 6D - Location of Gear Select Switch Fuse (Cherokee)

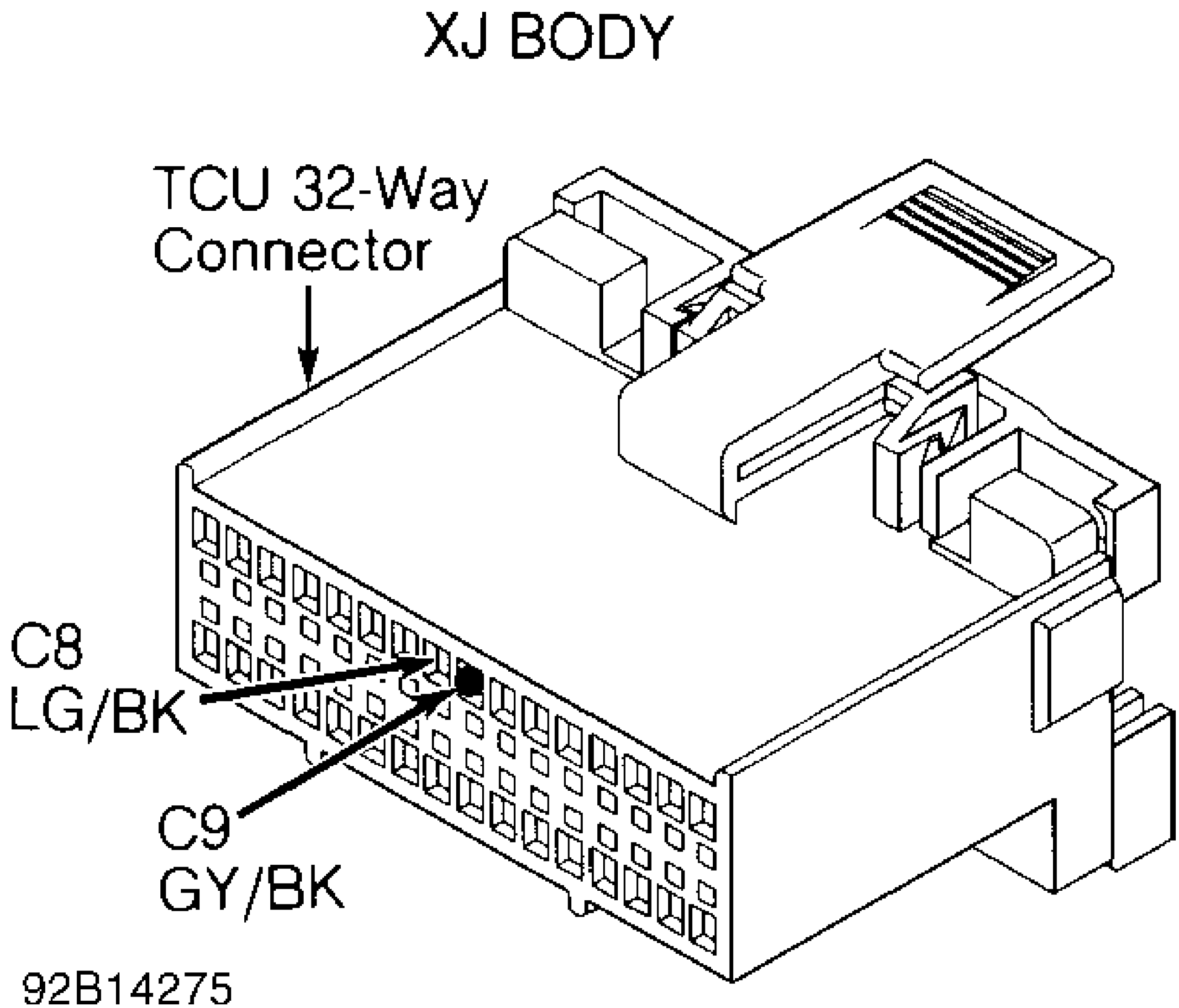


Fig. 75: Test 6D - TCU 32-Way Connector (Cavities 8 & 9, Cherokee)

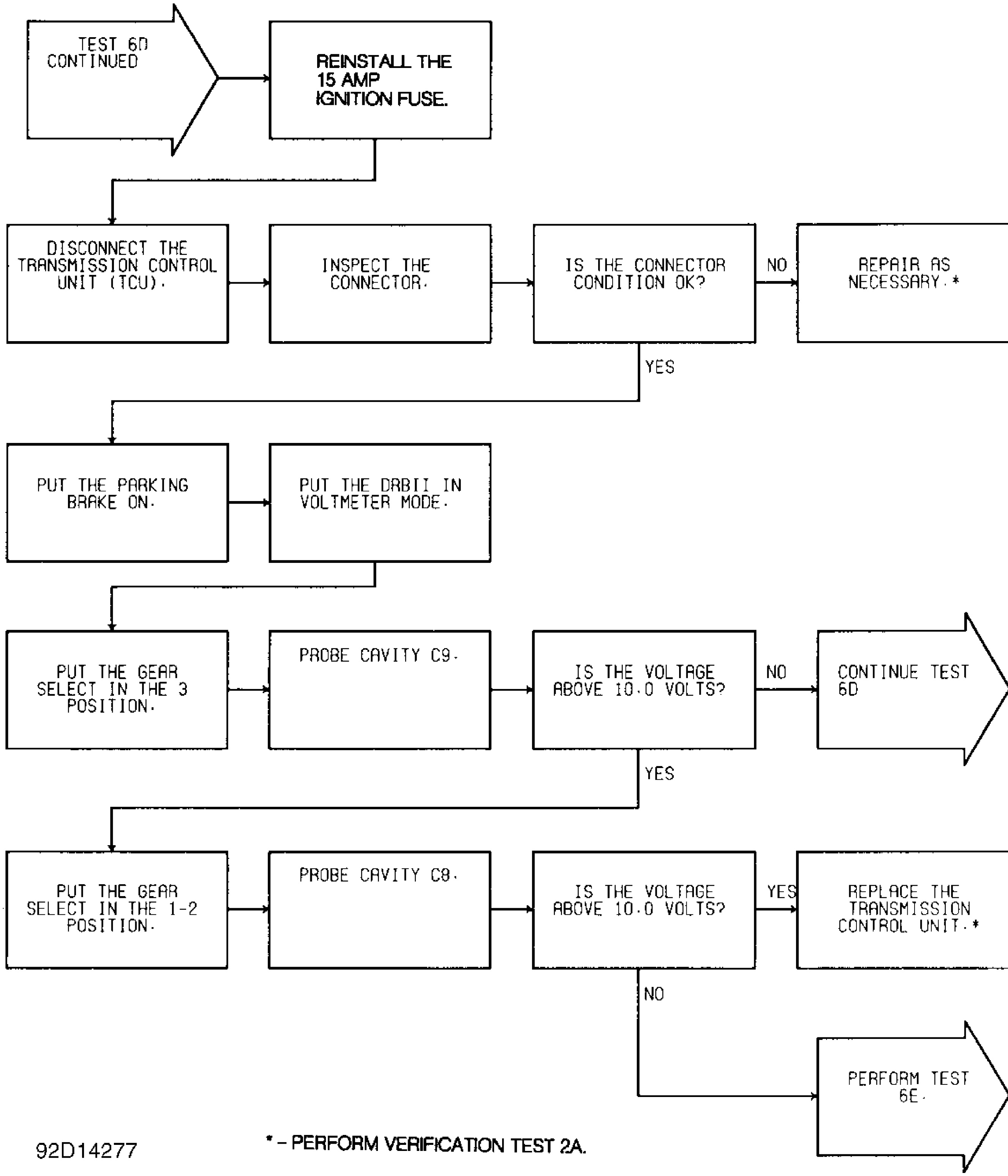
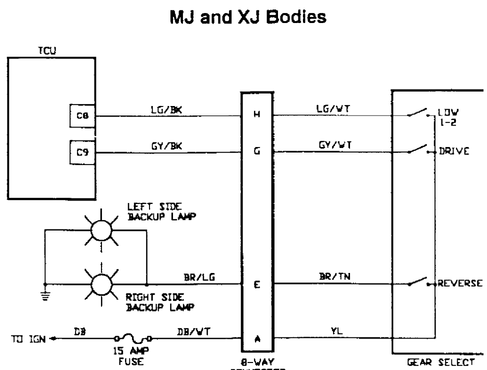
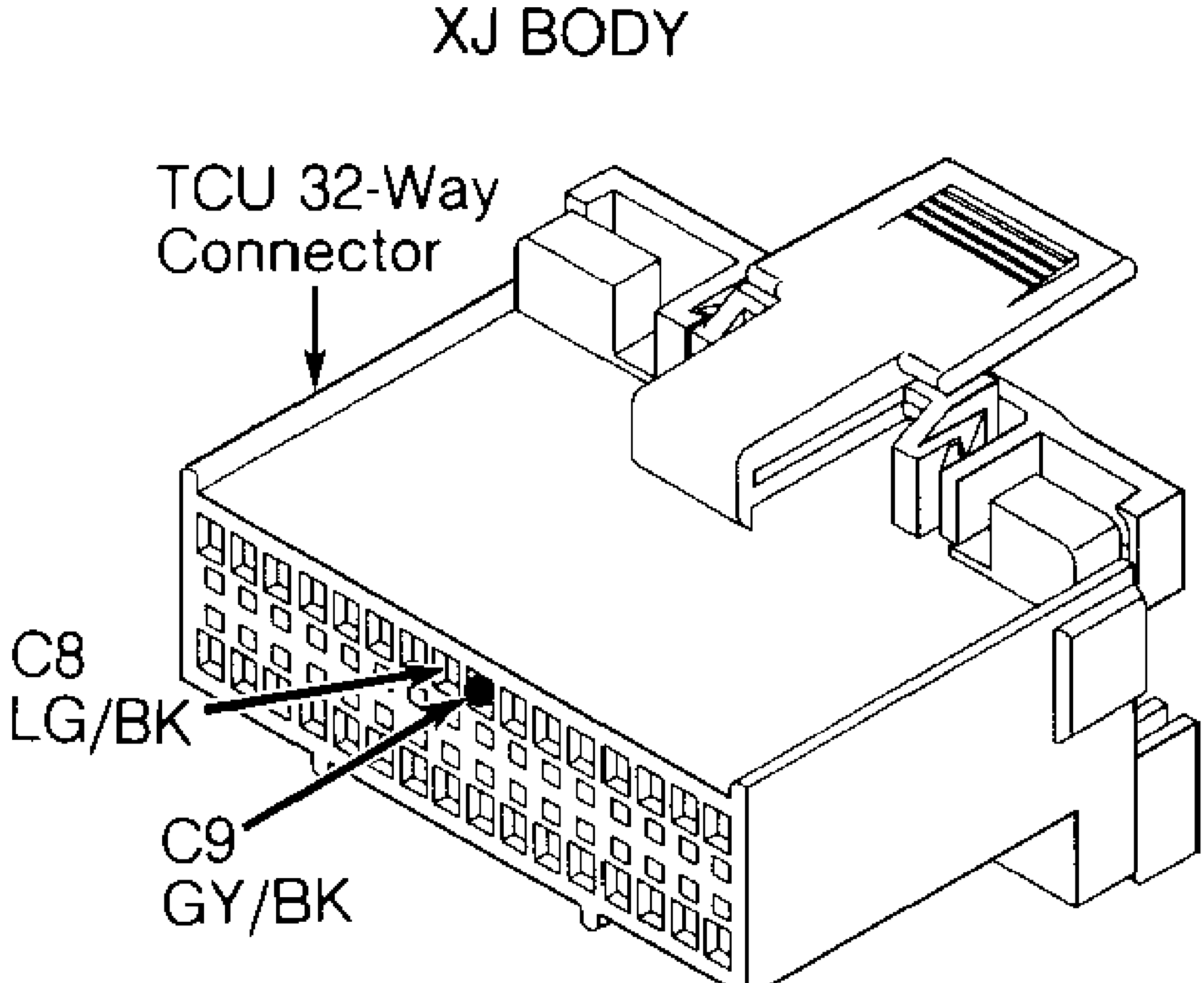


Fig. 76: Test 6D - Code 703, Flow Chart (2 of 3)



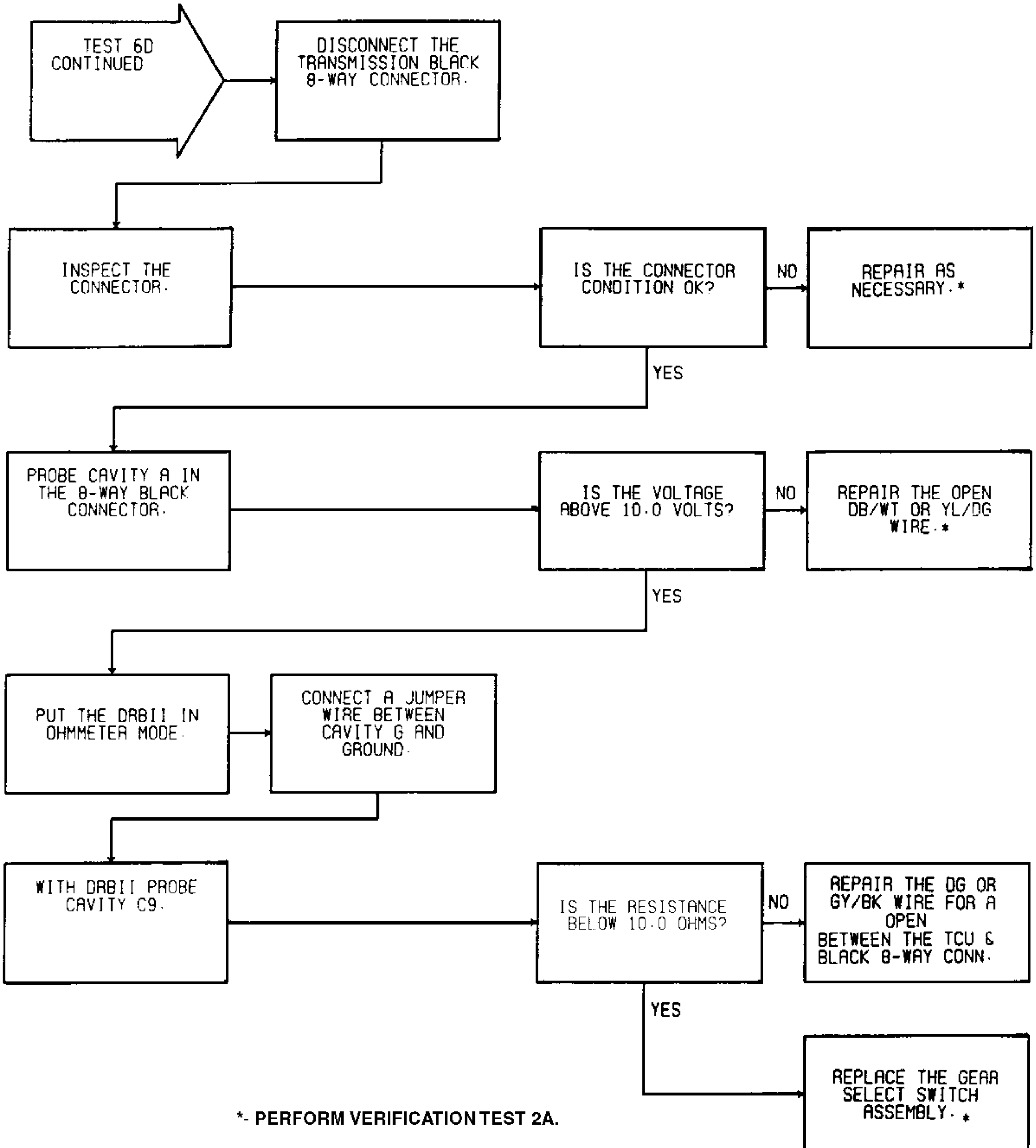
92A14258

Fig. 77: Test 6D - Gear Select Switch Schematic (Cherokee)



92B14275

Fig. 78: Test 6D - TCU 32-Way Connector (Cavities 8 & 9, Cherokee)



NOTE: See TEST 6A (1 OF 2) for wiring diagram.

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Fig. 79: Test 6D - Code 703, Flow Chart (3 of 3)

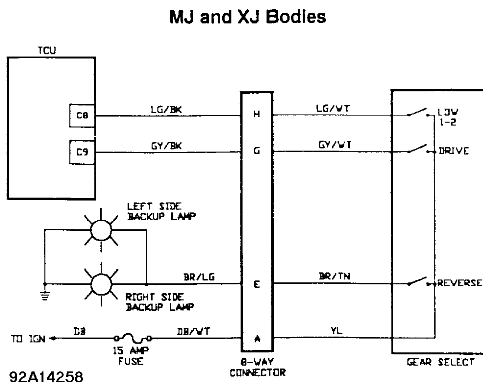


Fig. 80: Test 6D - Gear Select Switch Schematic (Cherokee)

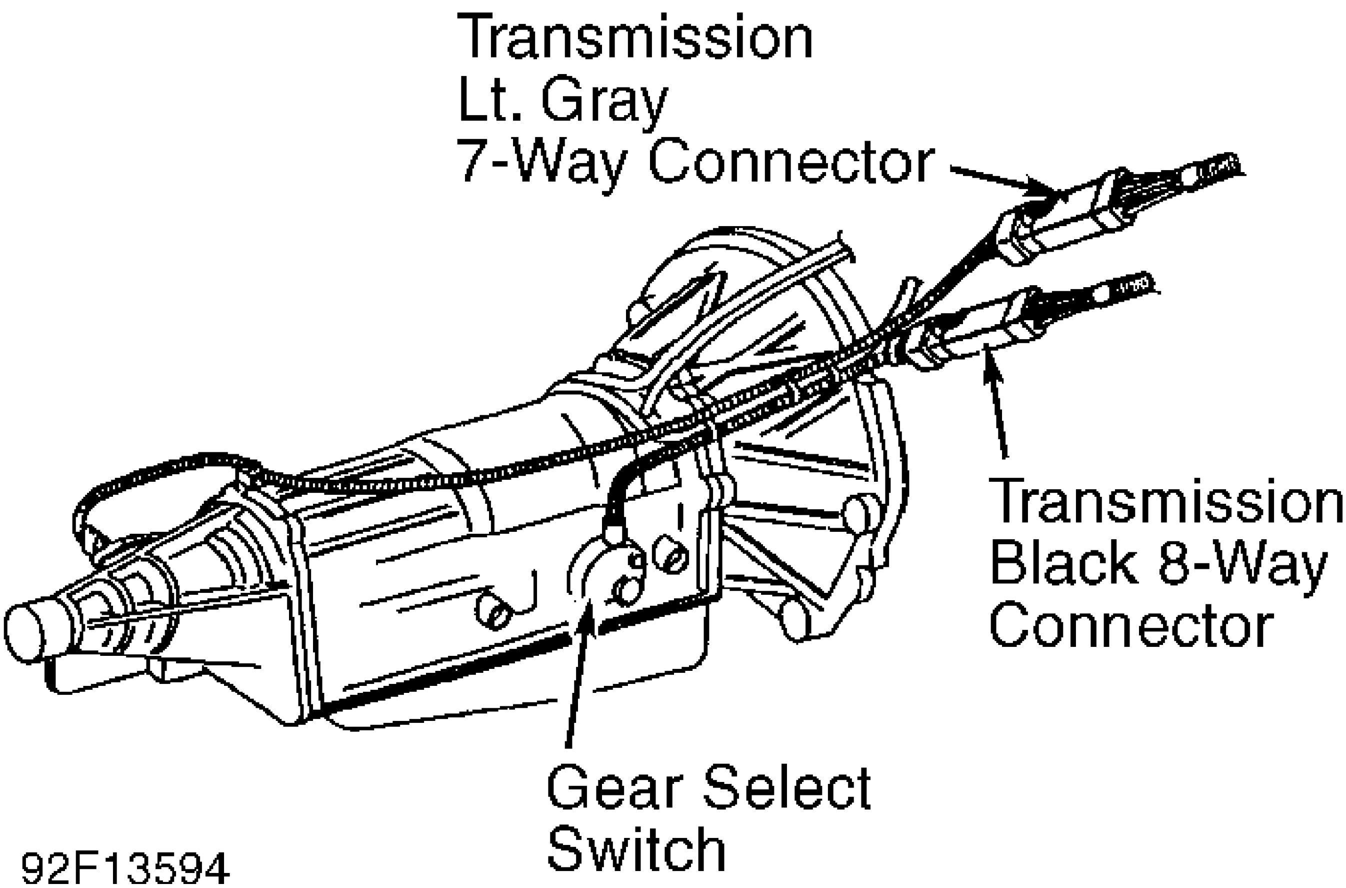


Fig. 81: Test 6D - Code 703, Location of Gear Select Switch

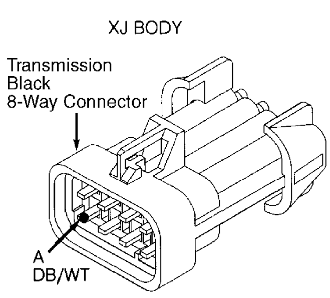


Fig. 82: Test 6D - 8-Way Black Connector Cavity "A" (Cherokee)

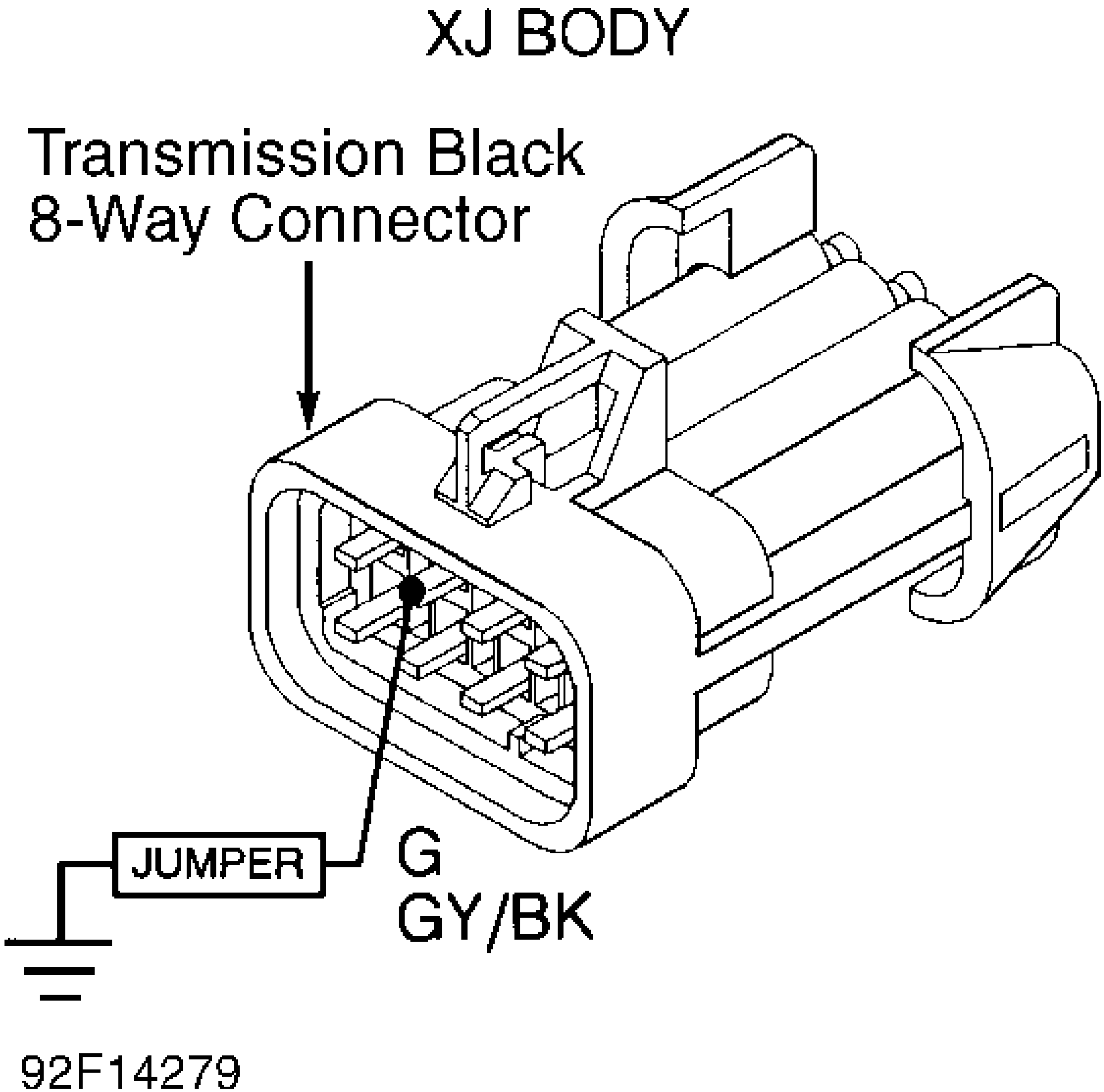


Fig. 83: Test 6D - 8-Way Black Connector Cavity "G" (Cherokee)

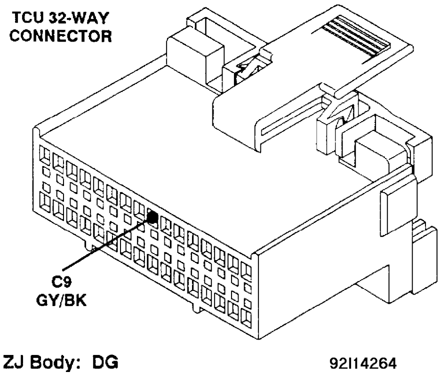


Fig. 84: Test 6D - Code 703, TCU 32-Way Connector (Cavity 9)

TEST 6E - CODE 703 - GEAR SELECT SWITCH CIRCUIT

NOTE: Perform TEST 6D - CODE 703 - GEAR SELECT SWITCH CIRCUIT before proceeding.

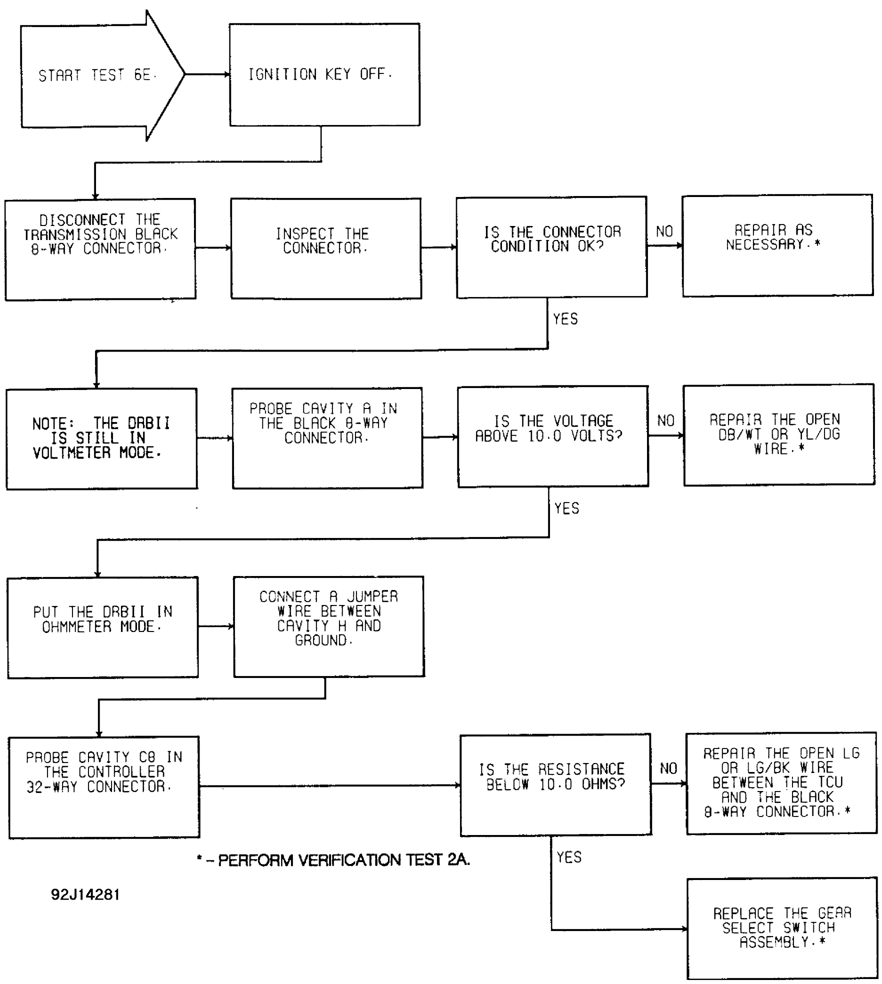


Fig. 85: Test 6E - Code 703, Flow Chart

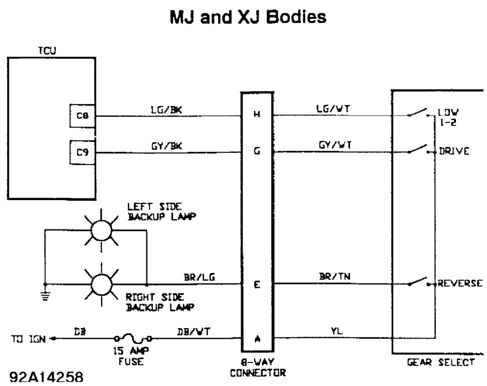


Fig. 86: Test 6E - Gear Select Switch Schematic (Cherokee)

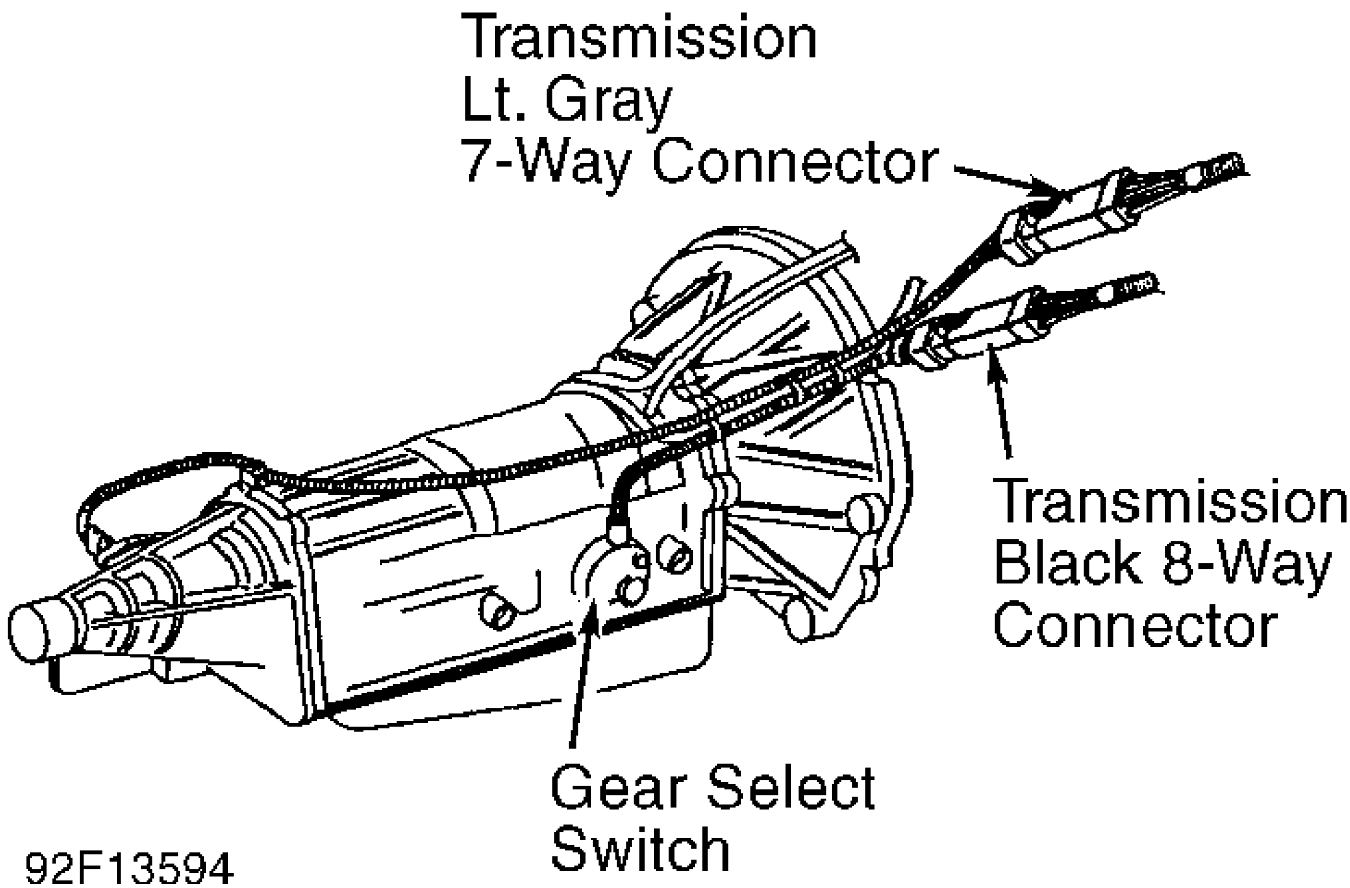


Fig. 87: Test 6E - Code 703, Location of Gear Select Switch

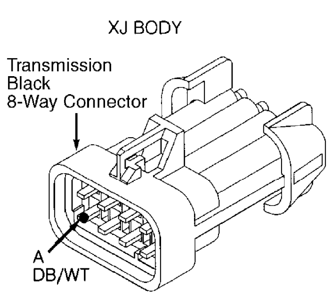


Fig. 88: Test 6E - 8-Way Black Connector Cavity "A" (Cherokee)

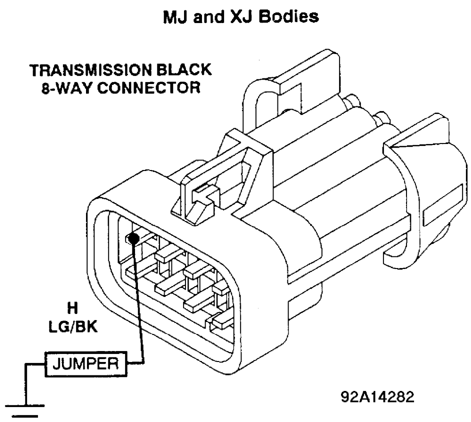


Fig. 89: Test 6E - 8-Way Black Connector Cavity "H" (Cherokee)

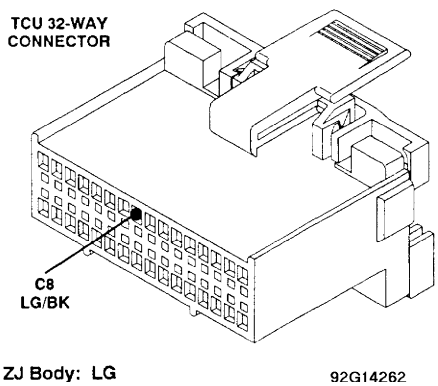


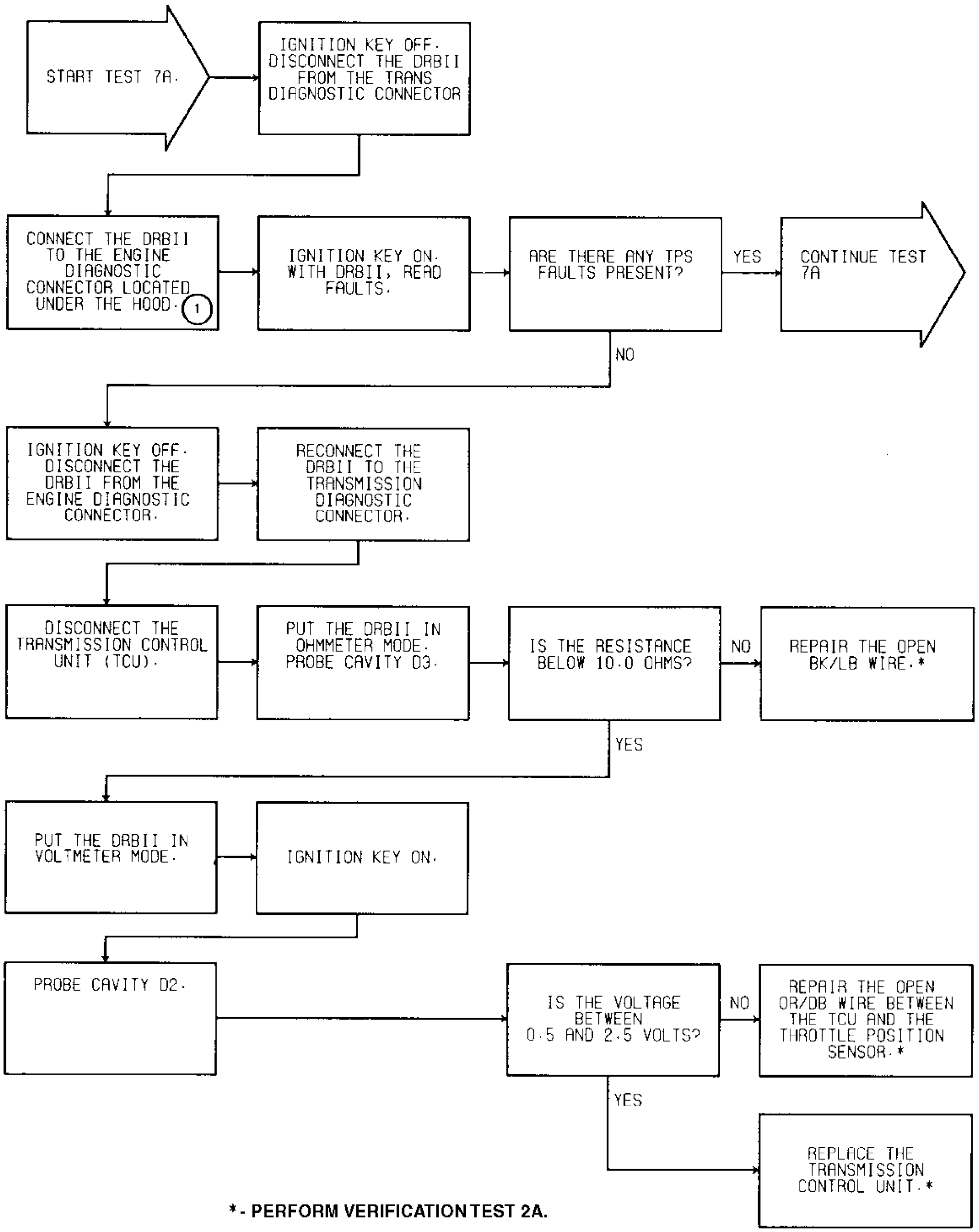
Fig. 90: Test 6E - TCU 32-Way Connector (Cavity 8)

TEST 7A - CODE 705 - TPS CIRCUIT

NOTE: Perform TEST 1A - VERIFICATION OF THE COMPLAINT before proceeding.

NOTE: On Cherokee, engine diagnostic connector is located at left side of engine compartment, near engine controller. Engine diagnostic connector is a 6-terminal connector.

Perform TEST 6D before proceeding.



1 - On XJ models, engine diagnostic connector is located at left side of engine compartment, near engine controller.

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Fig. 91: Test 7A - Code 705, Flow Chart (1 of 2)

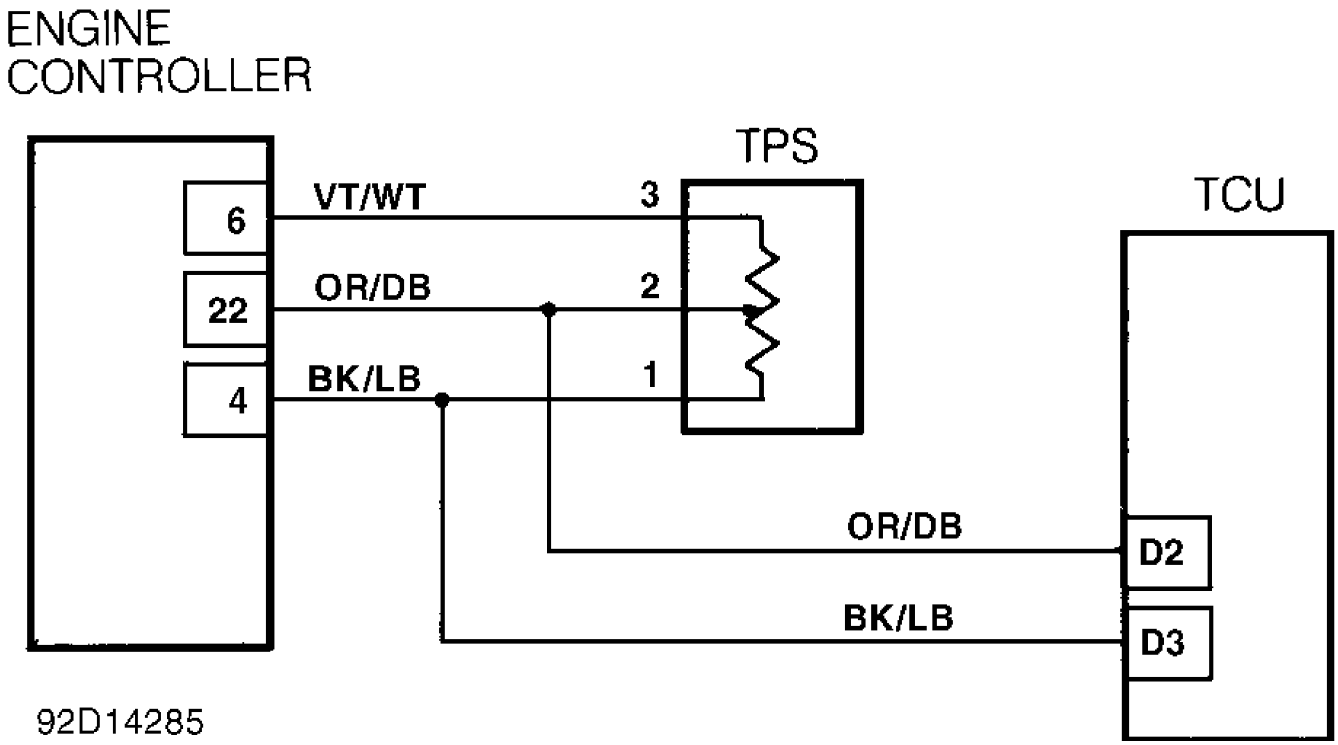


Fig. 92: Test 7A - Code 705, Schematic

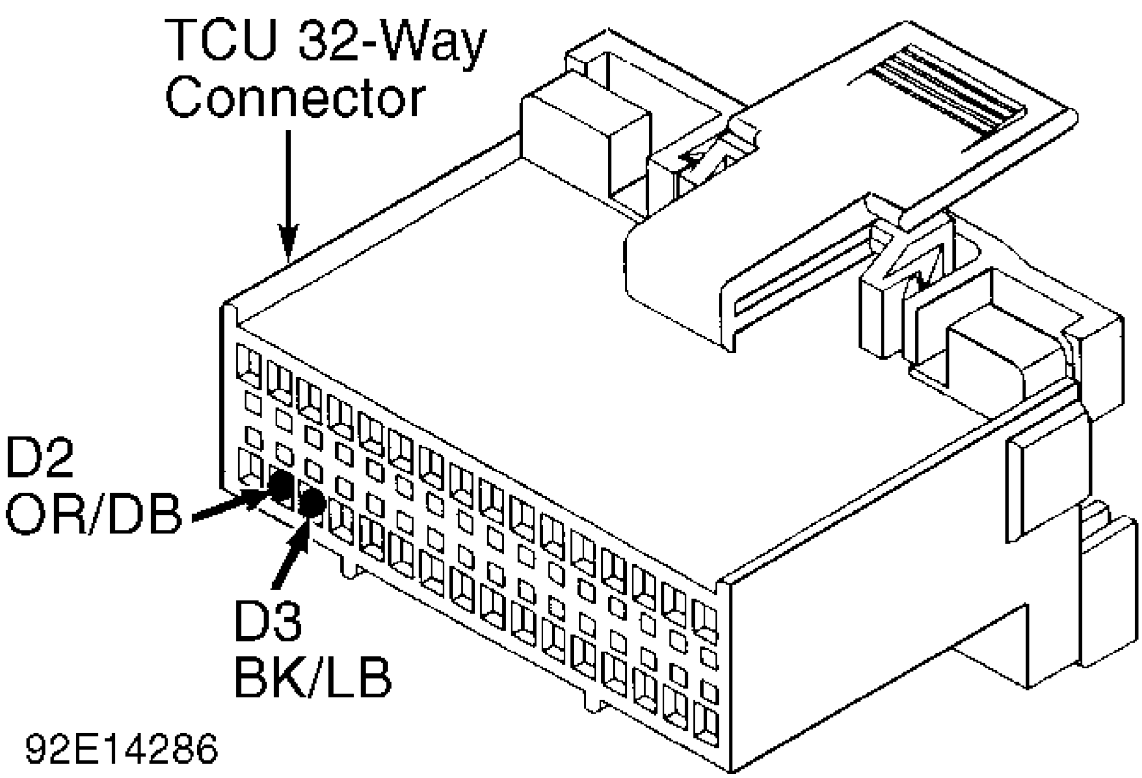


Fig. 93: Test 7A - TCU 32-Way Connector (Cavities D2 & D3)

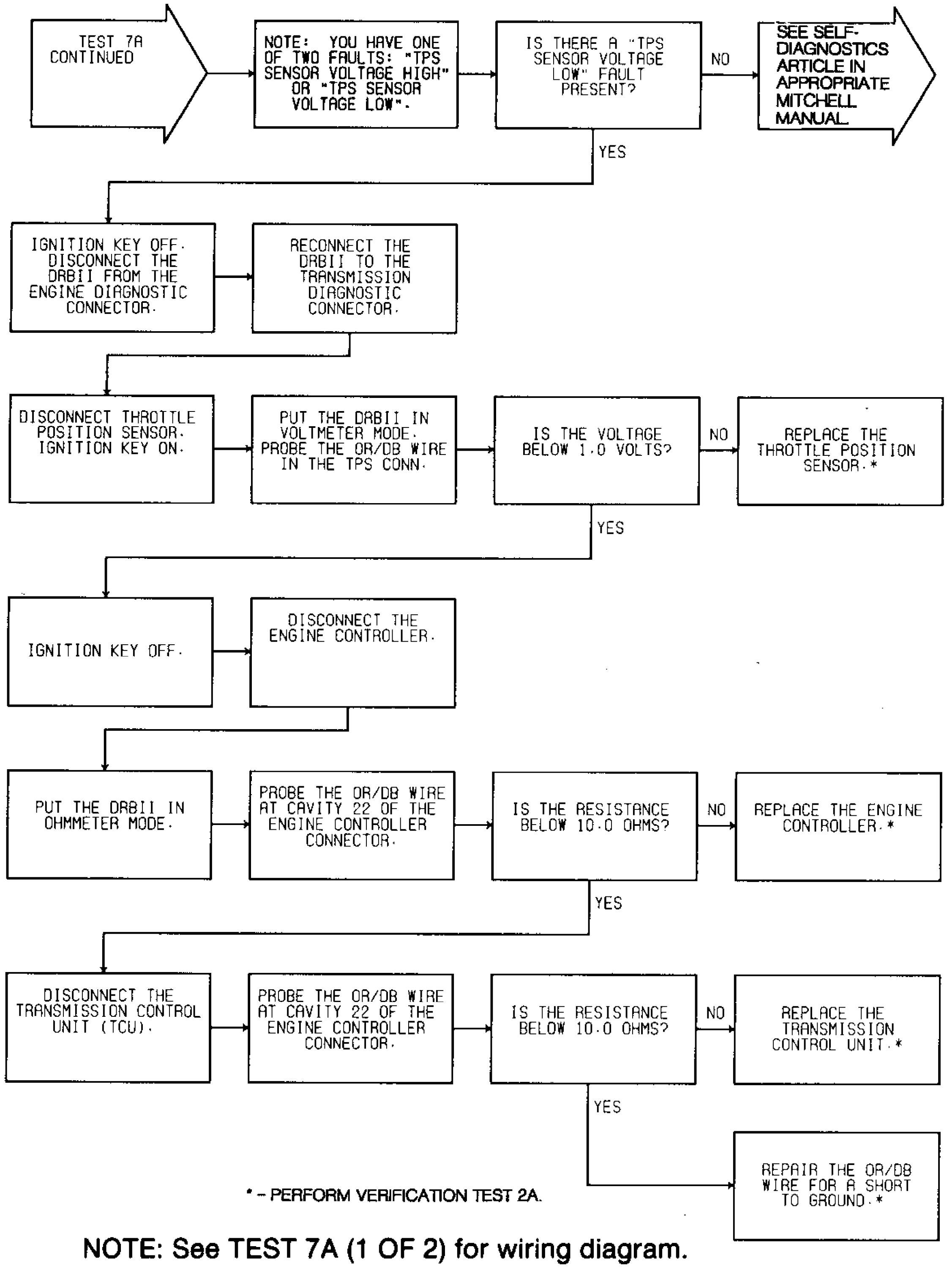


Fig. 94: Test 7A - Code 705, Flow Chart (2 of 2)

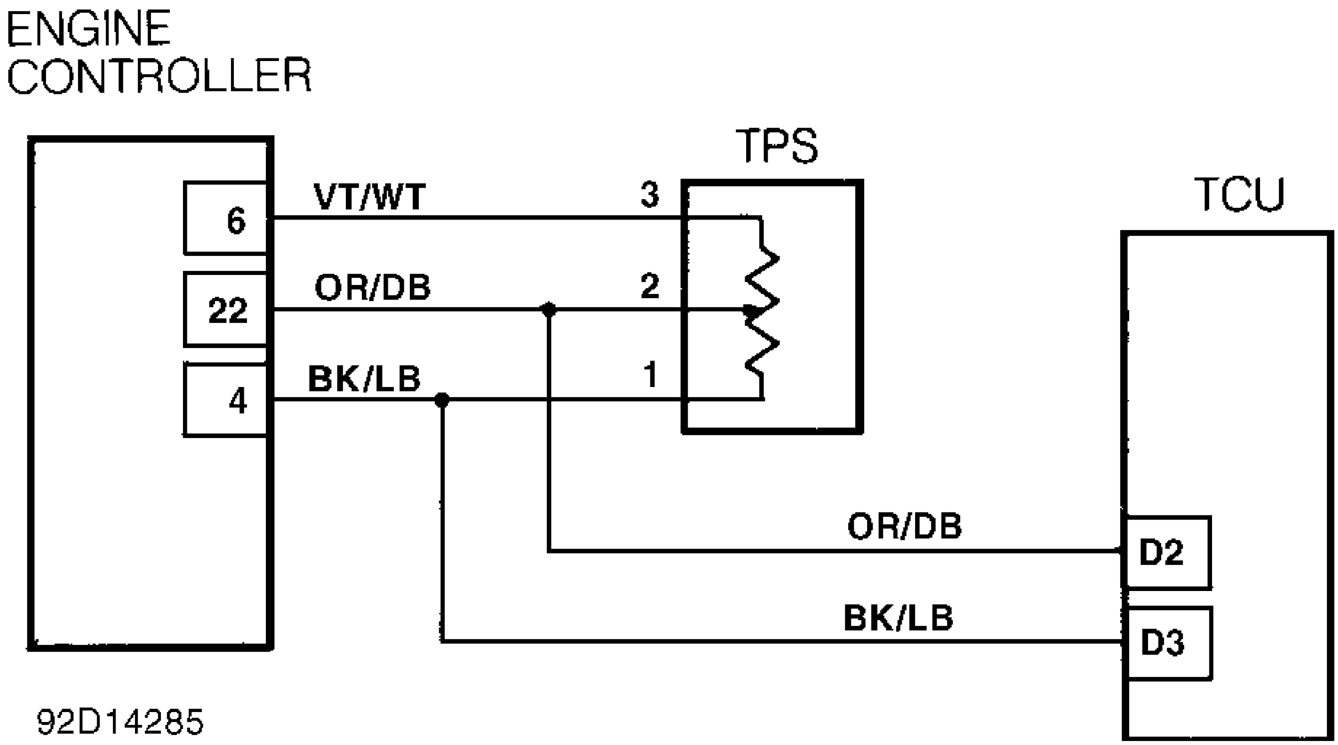


Fig. 95: Test 7A - Code 705, Schematic

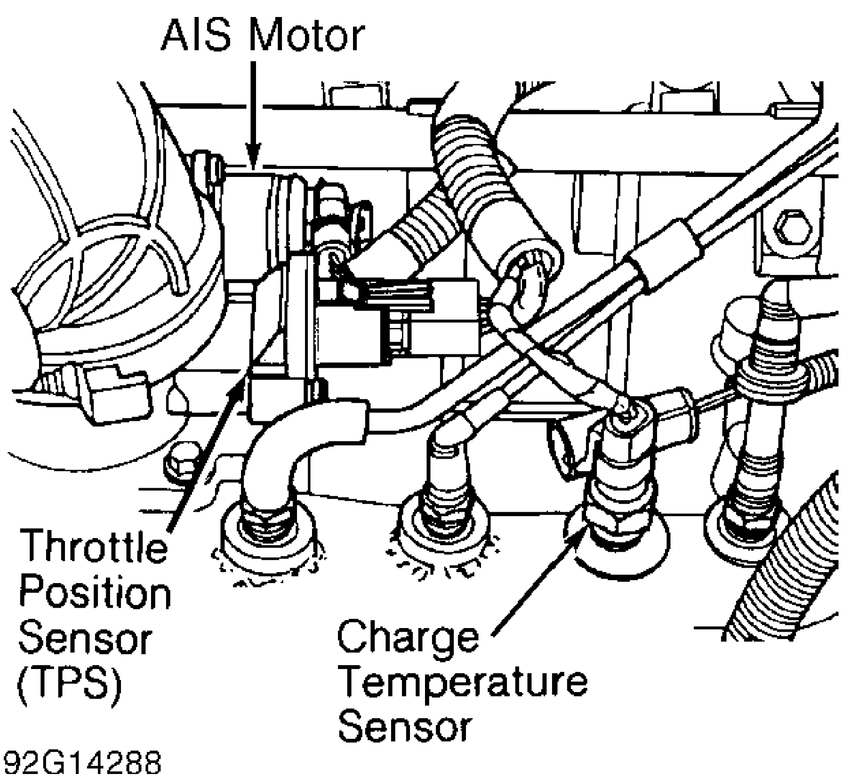


Fig. 96: Test 7A - Location of Throttle Position Sensor (TPS)

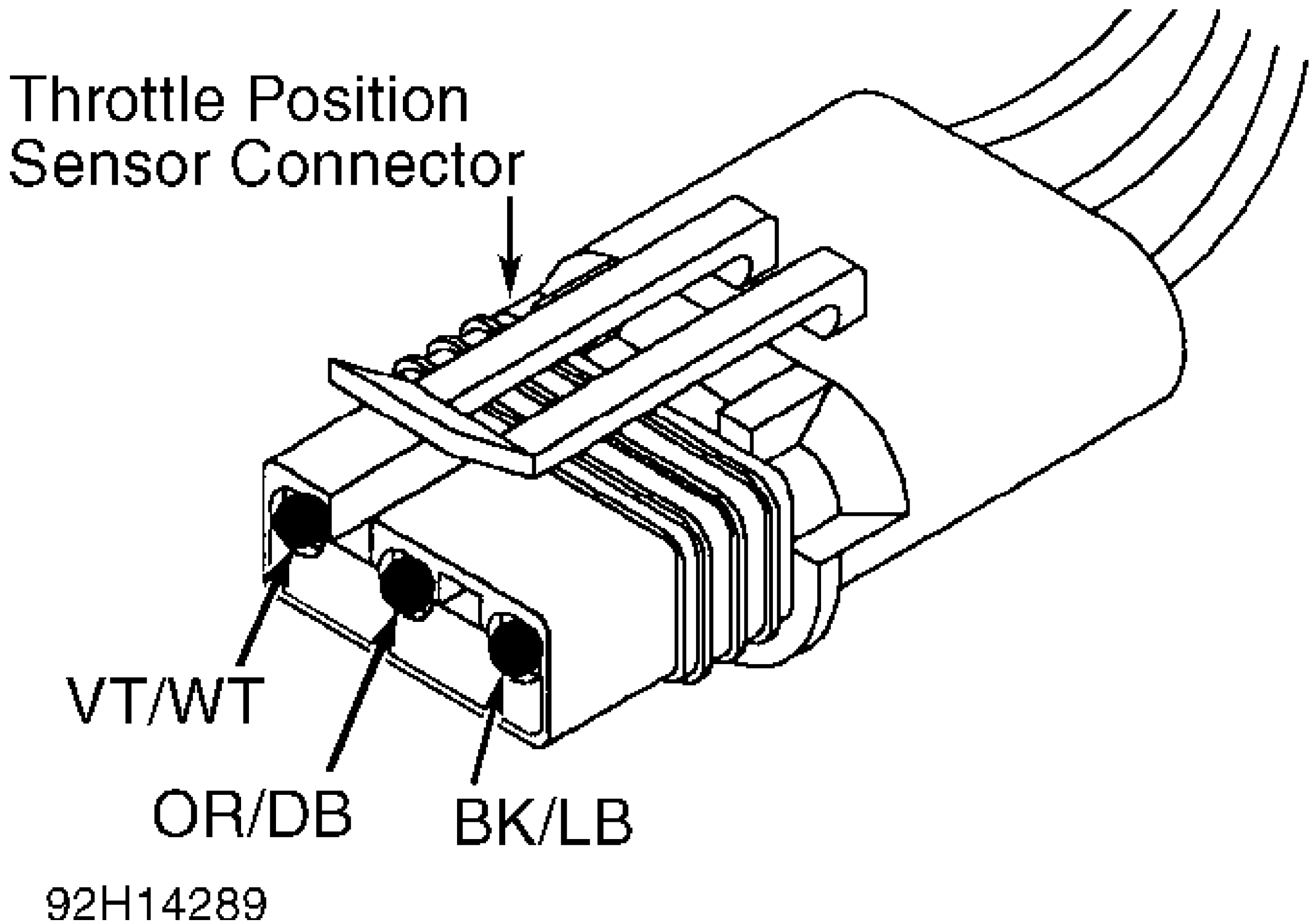


Fig. 97: Test 7A - Code 705, View of TPS Connector

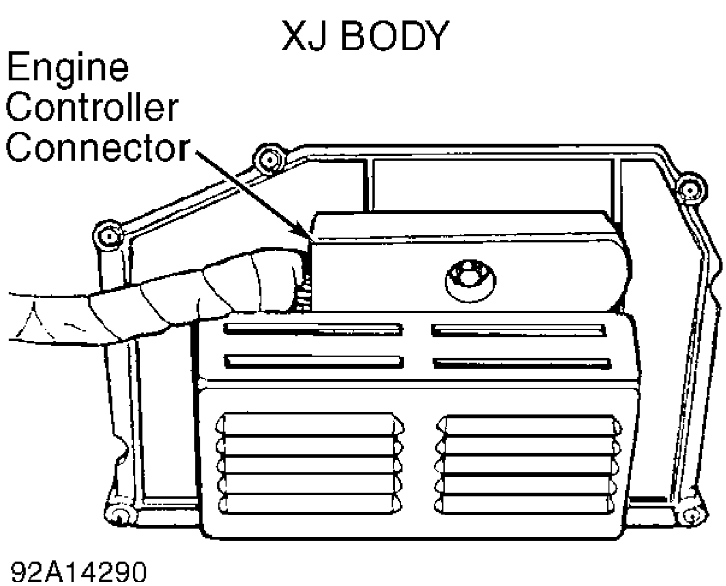


Fig. 98: Test 7A - Location of Engine Control Connector (Cherokee)

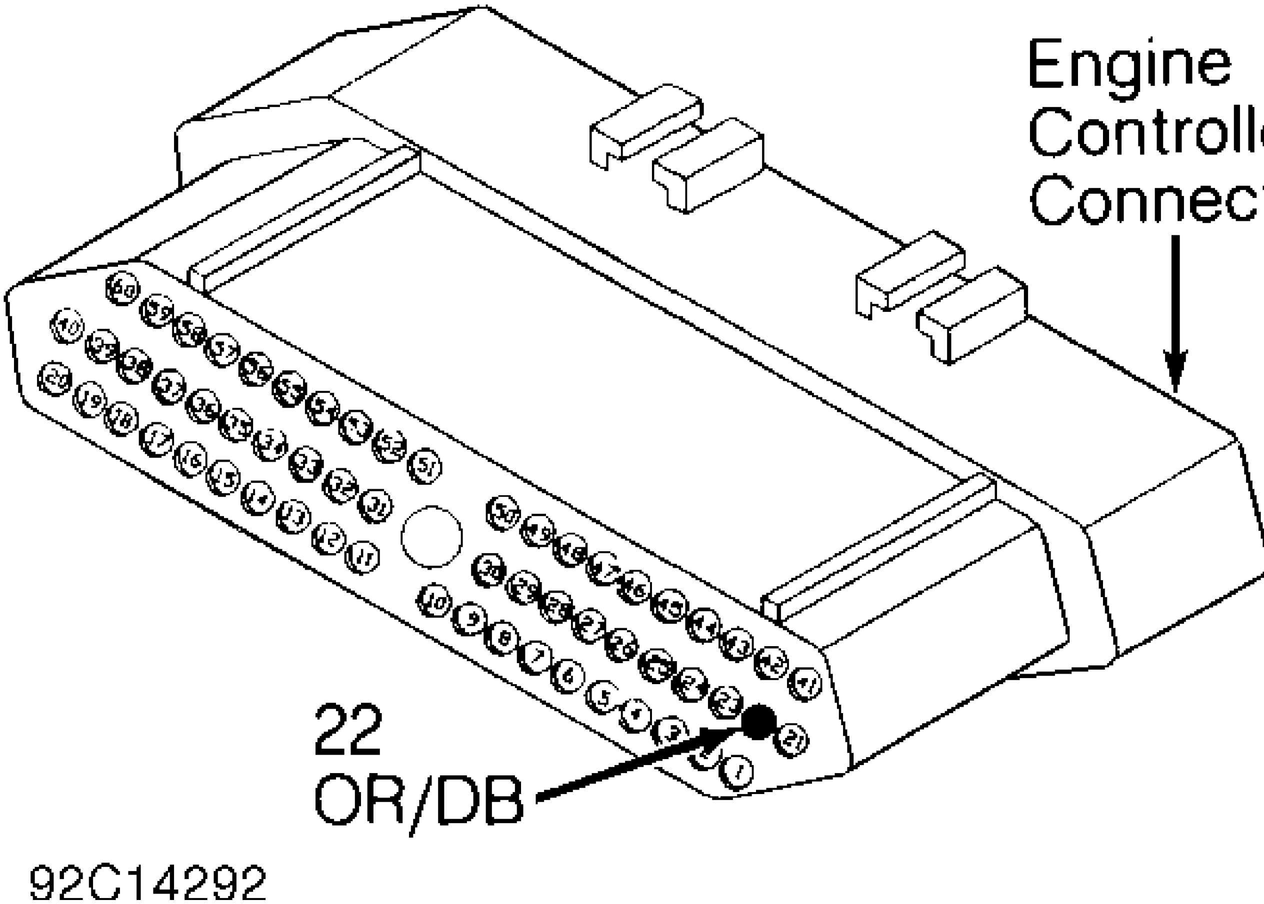


Fig. 99: Test 7A - View of Engine Control Connector (Cavity 22)

TEST 8A - CODE 706 - BRAKE SWITCH CIRCUIT

NOTE: Perform TEST 1A - VERIFICATION OF THE COMPLAINT before proceeding.

Perform TEST 1A before proceeding.

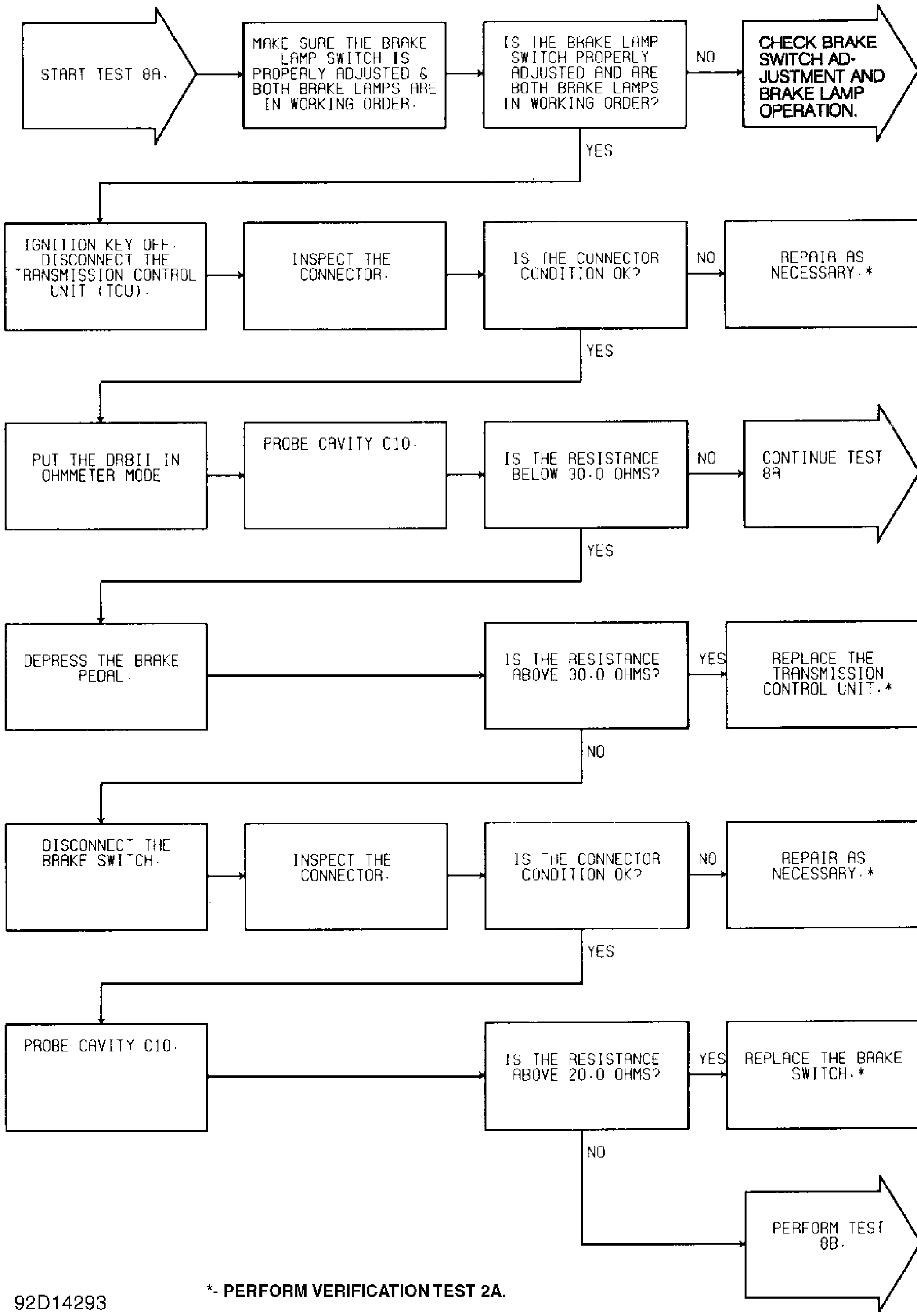


Fig. 100: Test 8A - Code 706, Flow Chart

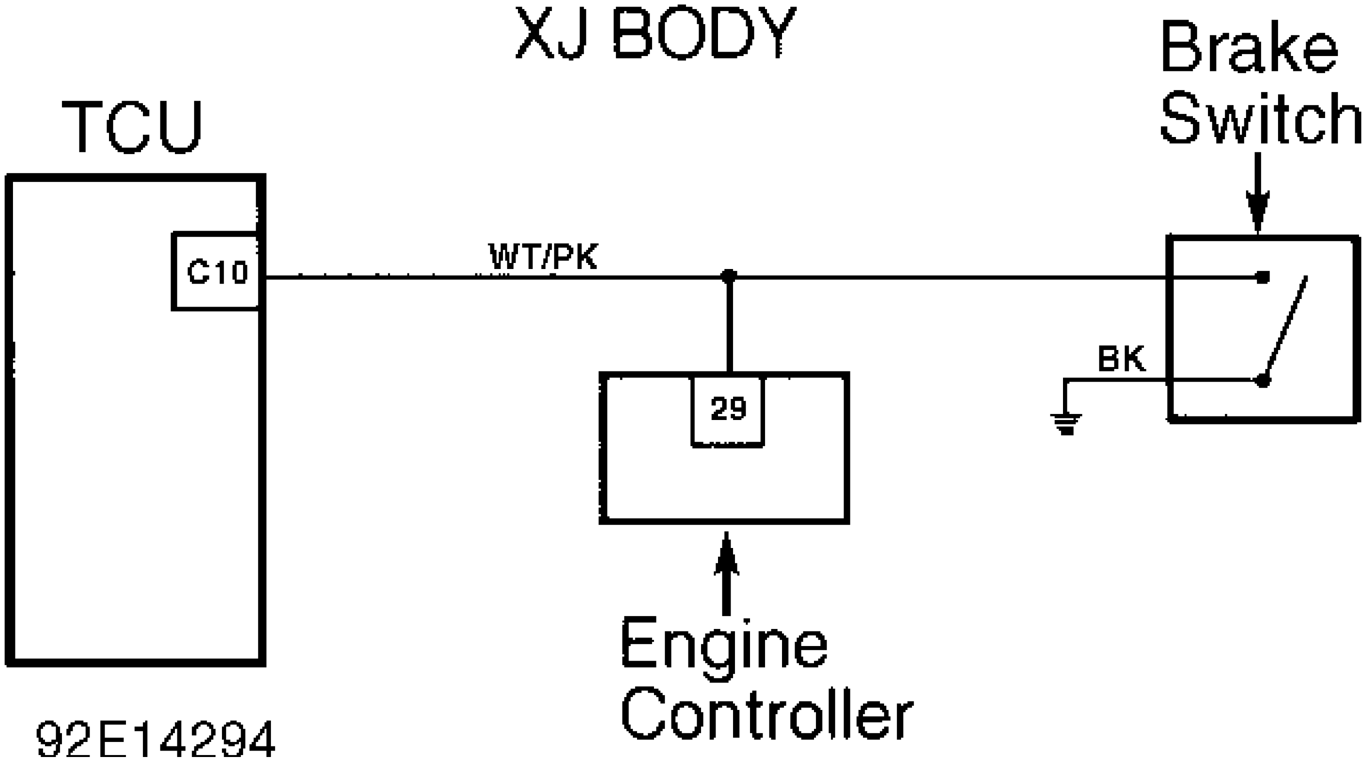


Fig. 101: Test 8A - Code 706, Schematic (Cherokee)

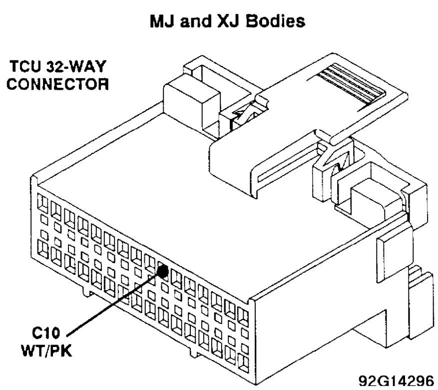


Fig. 102: Test 8A - TCU 32-Way Connector (Cavity 10, Cherokee)

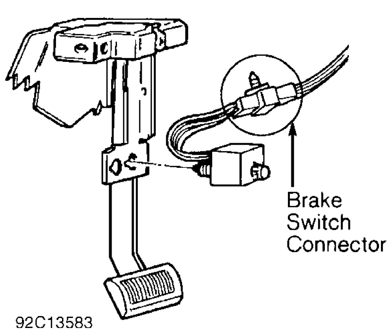


Fig. 103: Test 8A - Location of Brake Switch Connector

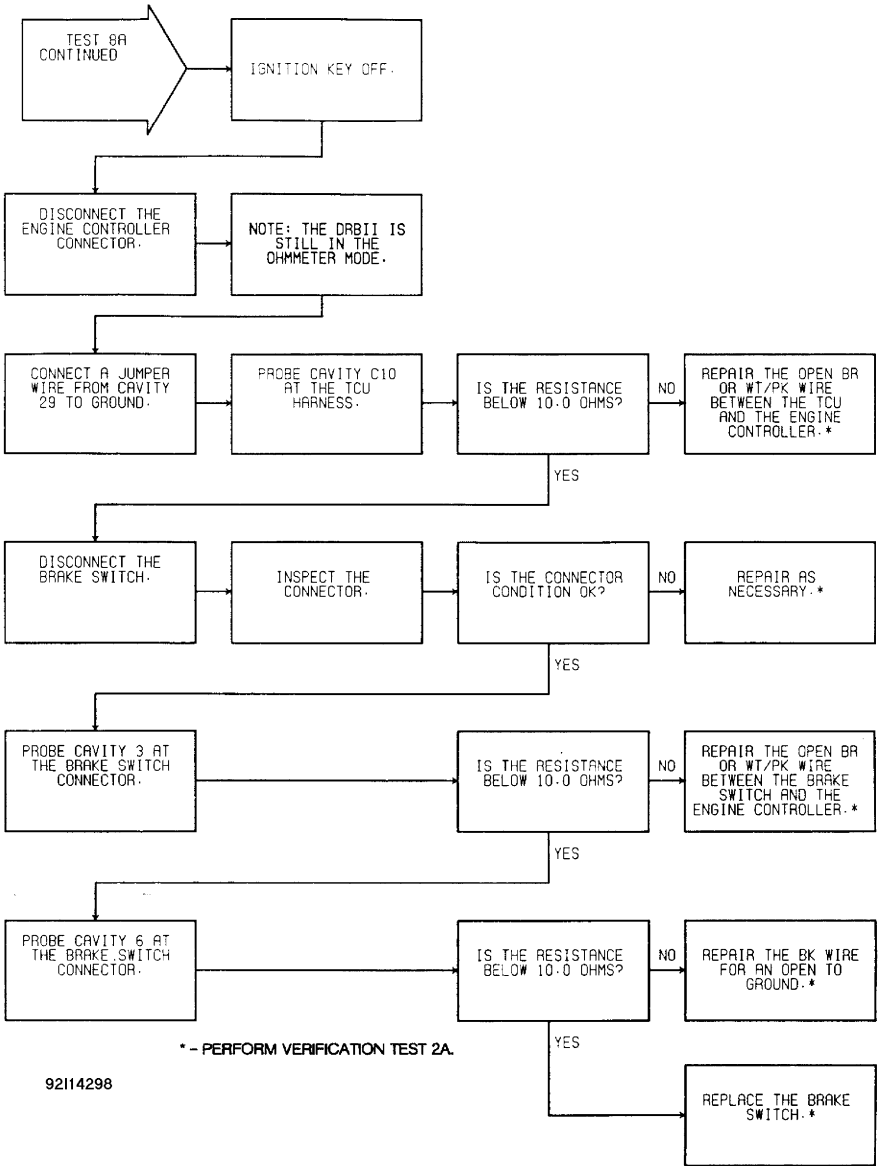


Fig. 104: Test 8A - Code 706, Flow Chart

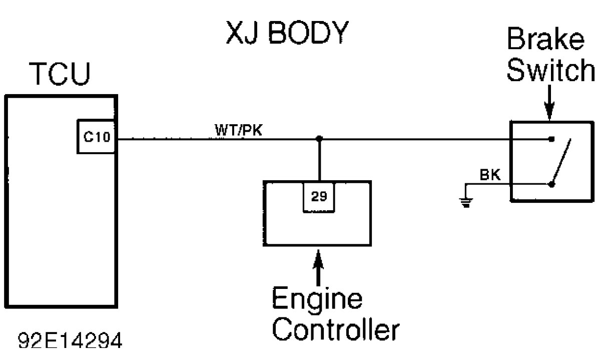


Fig. 105: Test 8A - Code 706, Schematic (Cherokee)

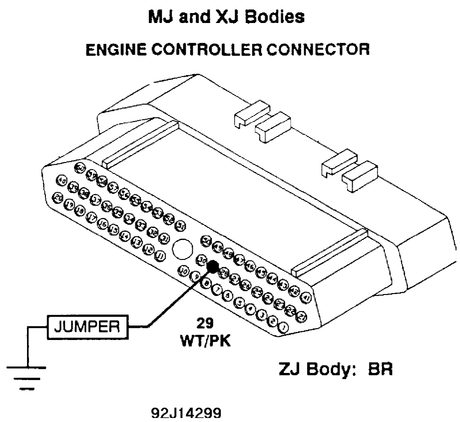


Fig. 106: Test 8A - View of Engine Controller Connector (Cavity 29)

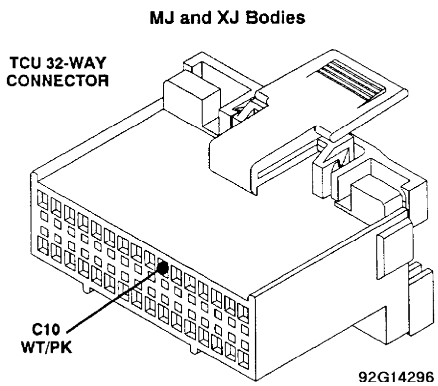


Fig. 107: Test 8A - TCU 32-Way Connector (Cavity 10, Cherokee)

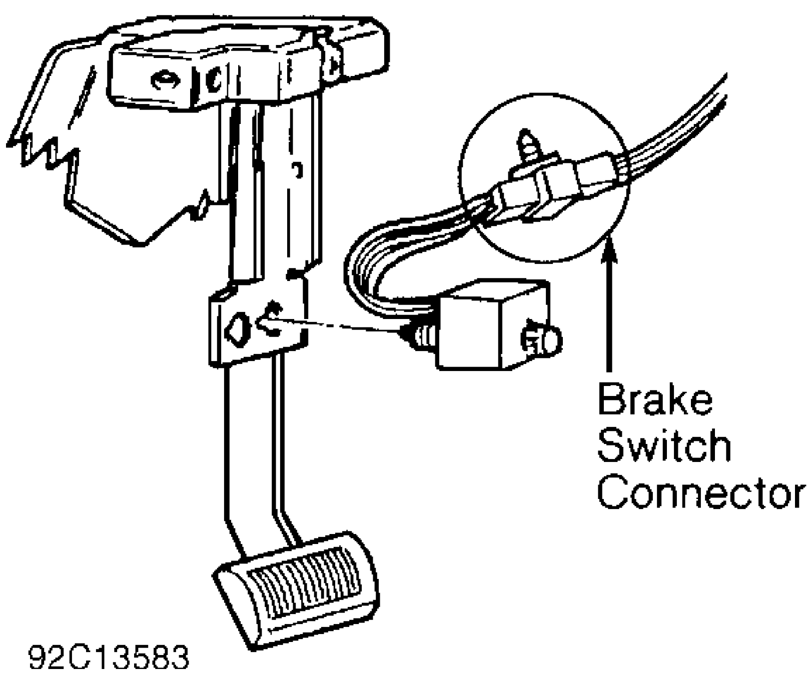


Fig. 108: Test 8A - Location of Brake Switch Connector

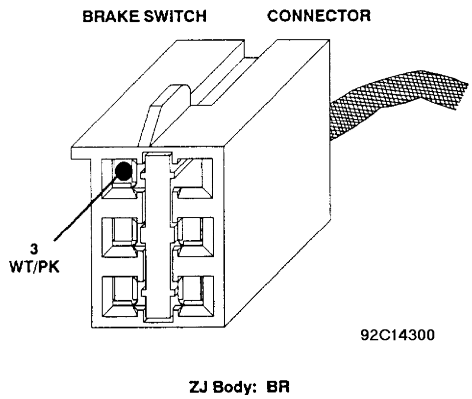


Fig. 109: Test 8A - View of Brake Switch Connector (Cavity 3)

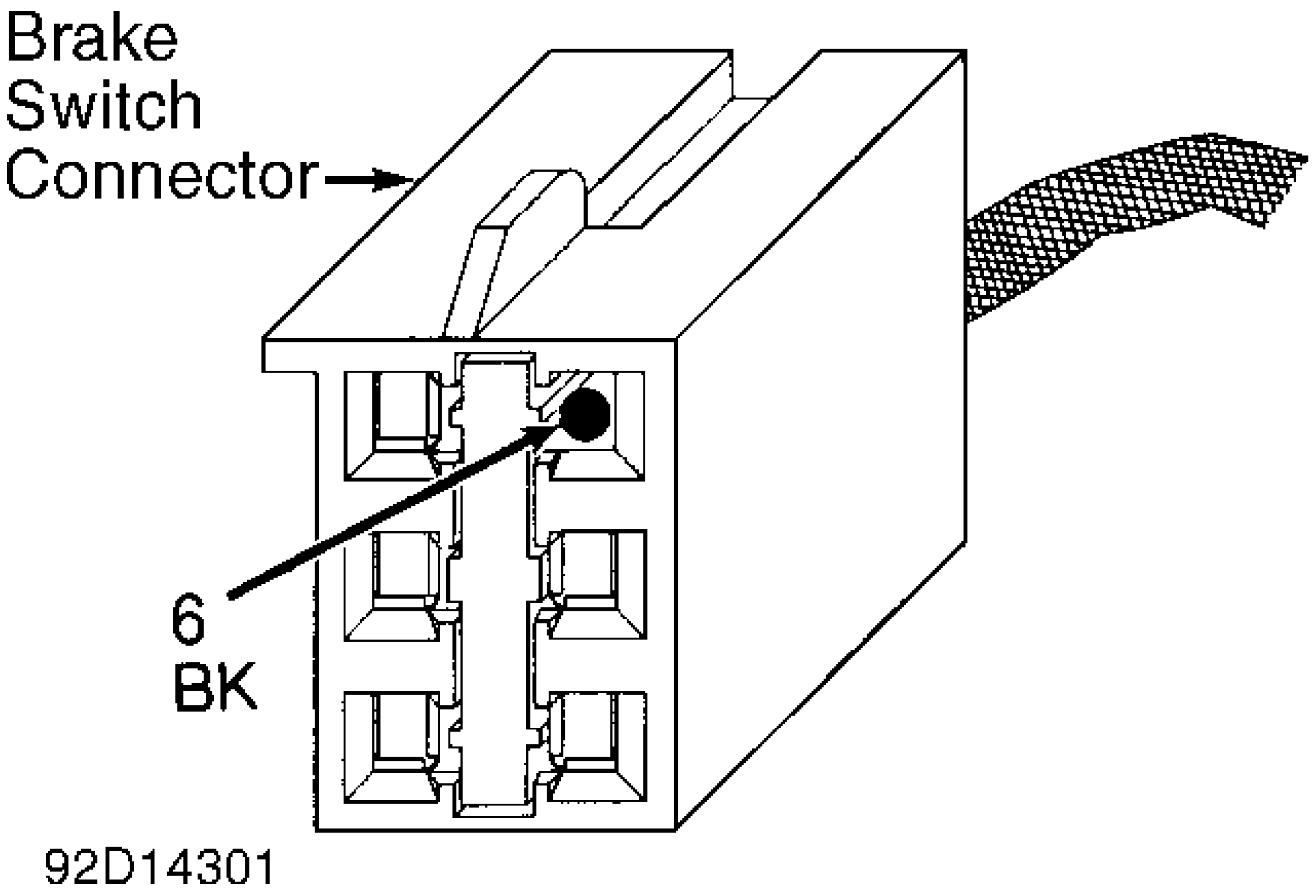
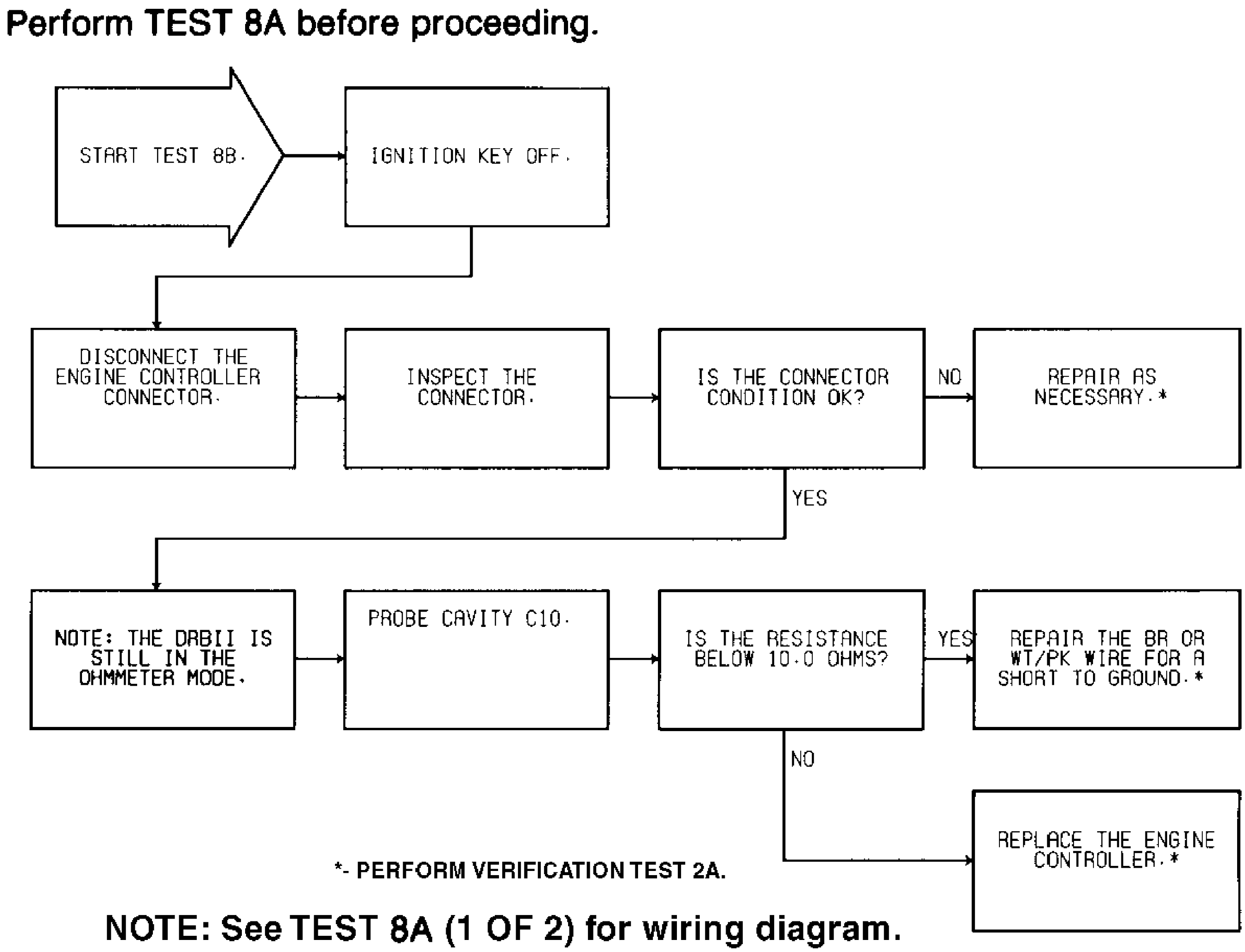


Fig. 110: Test 8A - View of Brake Switch Connector (Cavity 6)

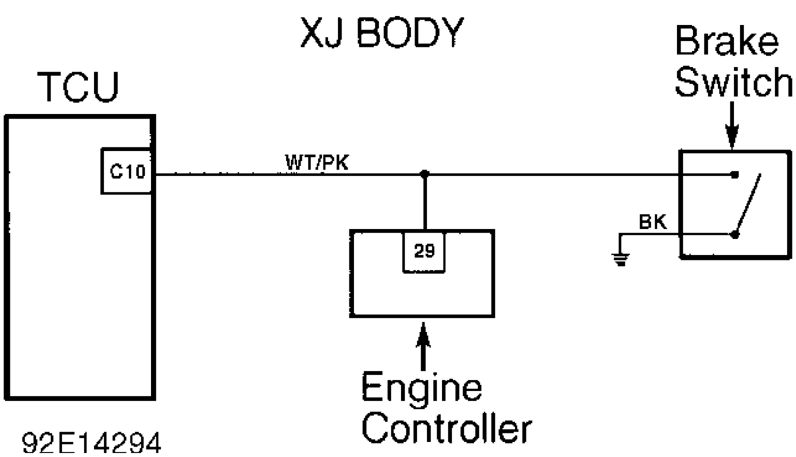
TEST 8B - CODE 706 - BRAKE SWITCH CIRCUIT

NOTE: Perform TEST 8A - CODE 706 - BRAKE SWITCH CIRCUIT before proceeding.



92E14302

Fig. 111: Test 8B - Code 706, Flow Chart



92E14294

Fig. 112: Test 8B - Code 706, Schematic (Cherokee)

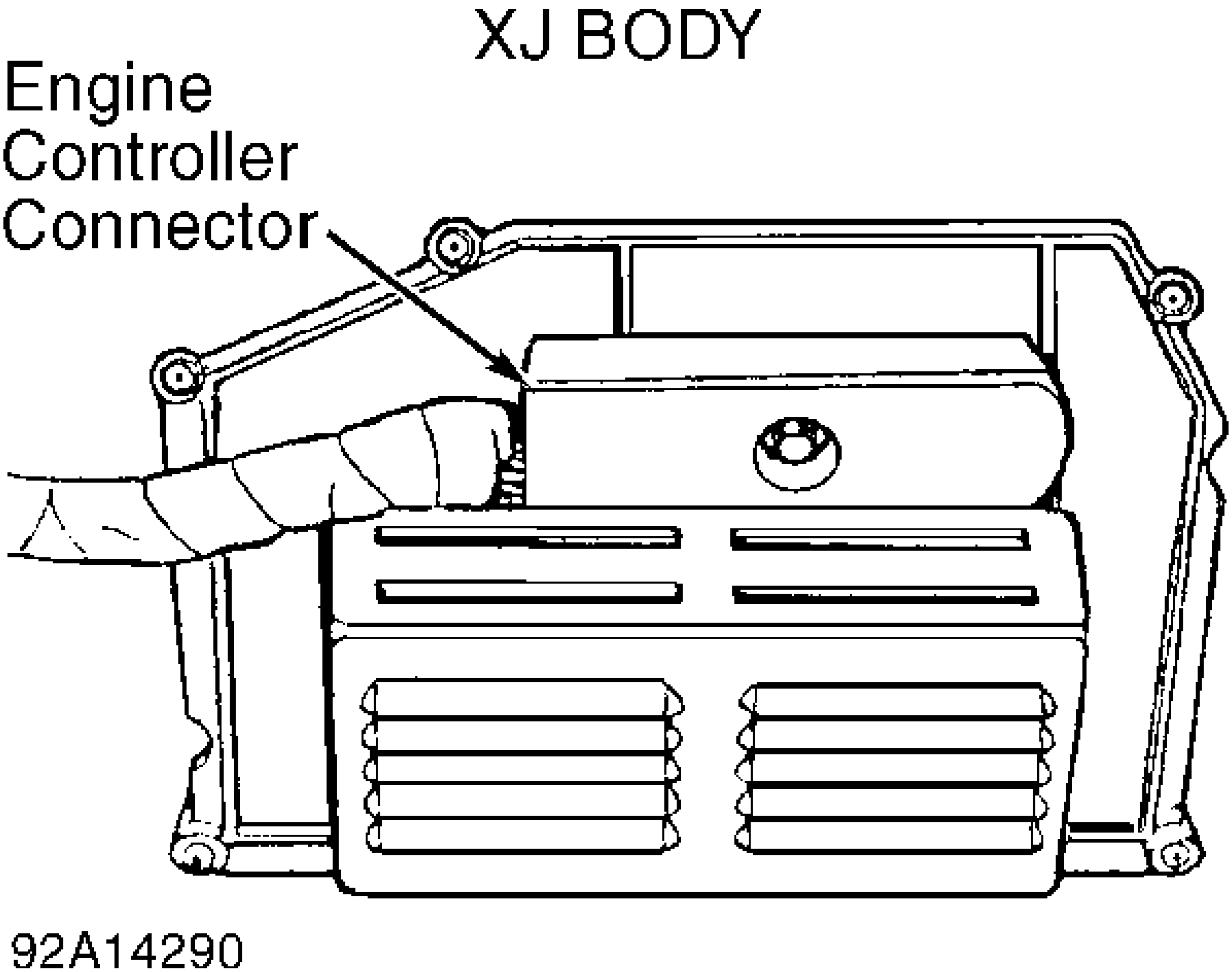


Fig. 113: Test 7A - Location of Engine Control Connector (Cherokee)

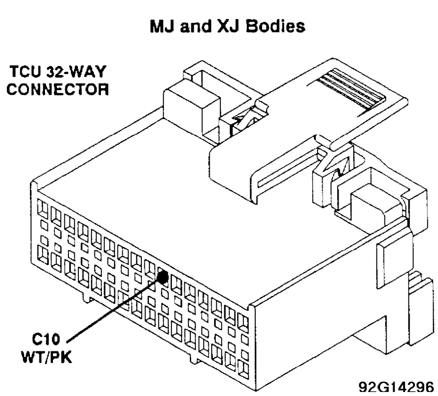


Fig. 114: Test 8B - TCU 32-Way Connector (Cavity 10, Cherokee)

TEST 9A - WRONG TCU

NOTE: Perform TEST 1A - VERIFICATION OF THE COMPLAINT before proceeding.

NOTE: The AW-4 is used only on 4.0L. In earlier years, it was

used with 2.5.L

The DRB-II has determined that the wrong Transmission Control Unit (TCU) has been installed in the vehicle. There are two transmission control units available for the Jeep AW4 transmission. One is for the 4-cylinder 2.5L engine and the other is for the 6-cylinder 4.0L engine.

1) using the DRB-II, read MODULE INFO. See HELP 1 for assistance.
2) Determine what vehicle should be in the vehicle.

* 2.5L Engine: TCU 02 (Used in earlier years only)
* 4.0L Engine: TCU 01 (1993-94)

3) If the wrong transmission control unit is installed, the vehicle shift points will be slightly different (the 2.5L engine TCU has higher shift points).

TEST 10A - TESTING FOR INTERMITTENT SPEED SENSOR

NOTE: Perform TEST 1A - VERIFICATION OF THE COMPLAINT before proceeding.

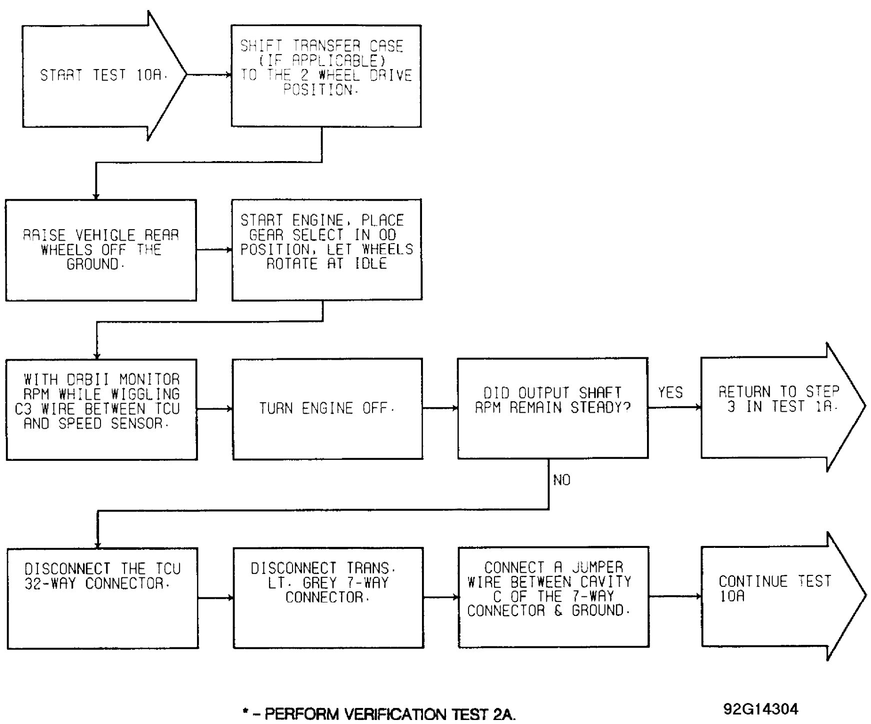


Fig. 115: Test 10A - Flow Chart (1 of 2)

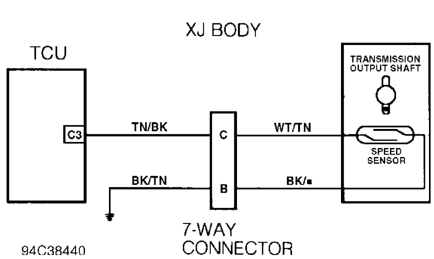


Fig. 116: Test 10A - Schematic (Cherokee)

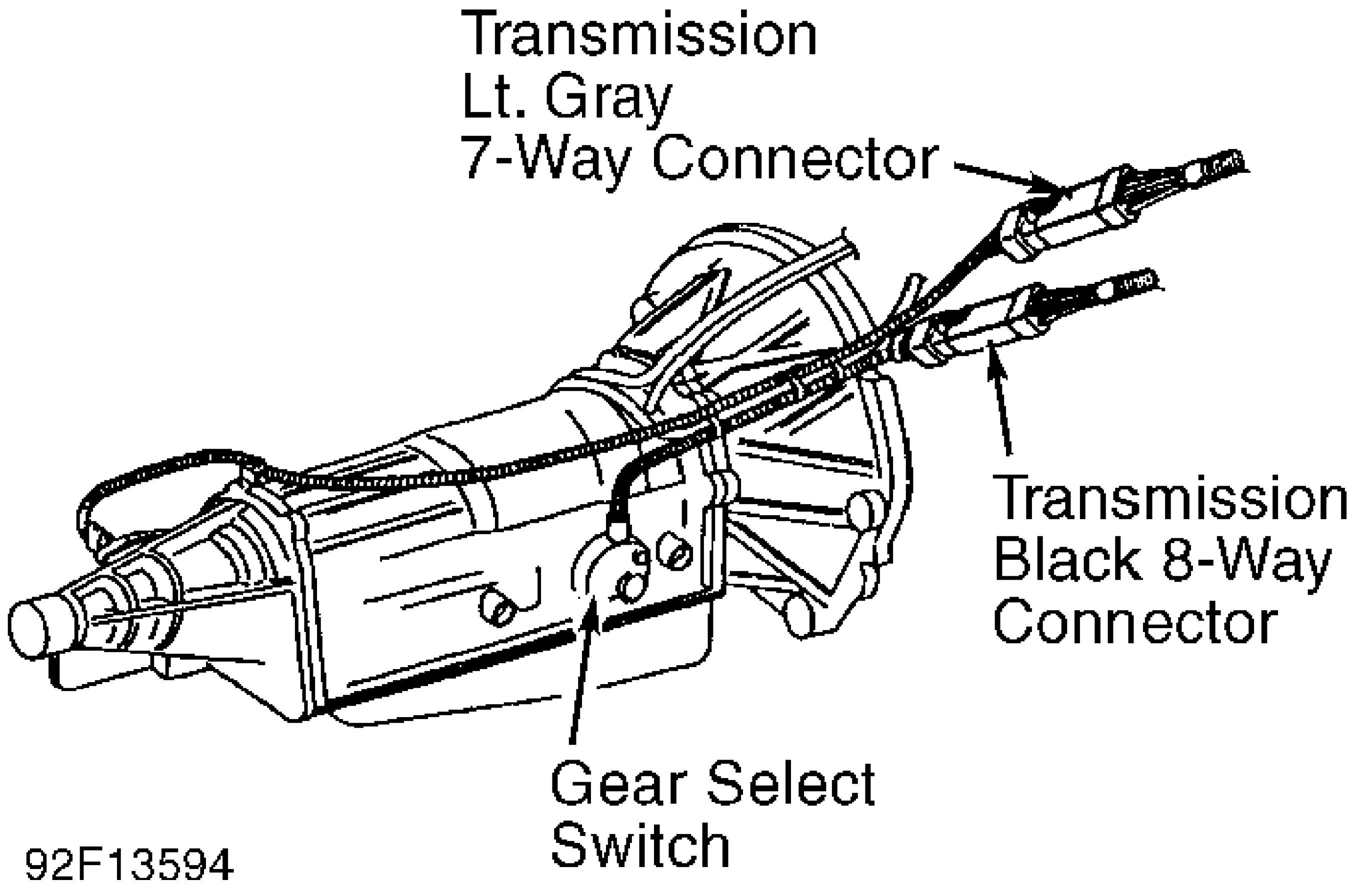


Fig. 117: Test 10A - Location of Transmission Connectors

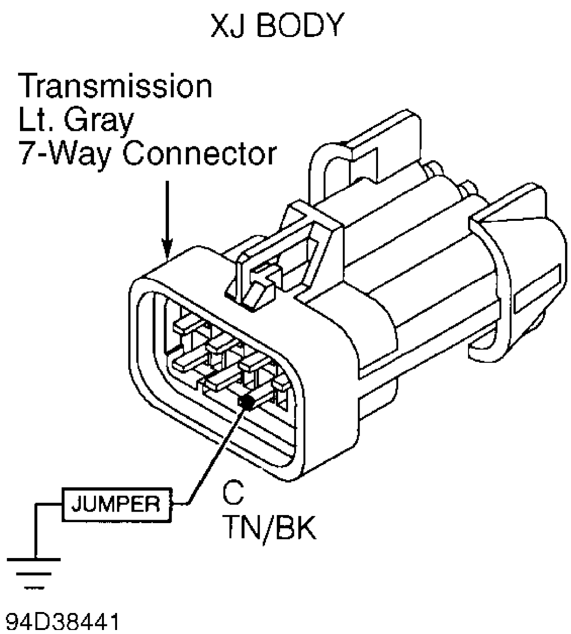


Fig. 118: Test 10A - View of 7-Way Connector (Cherokee)

NOTE: See Fig. 115 for wiring diagram.

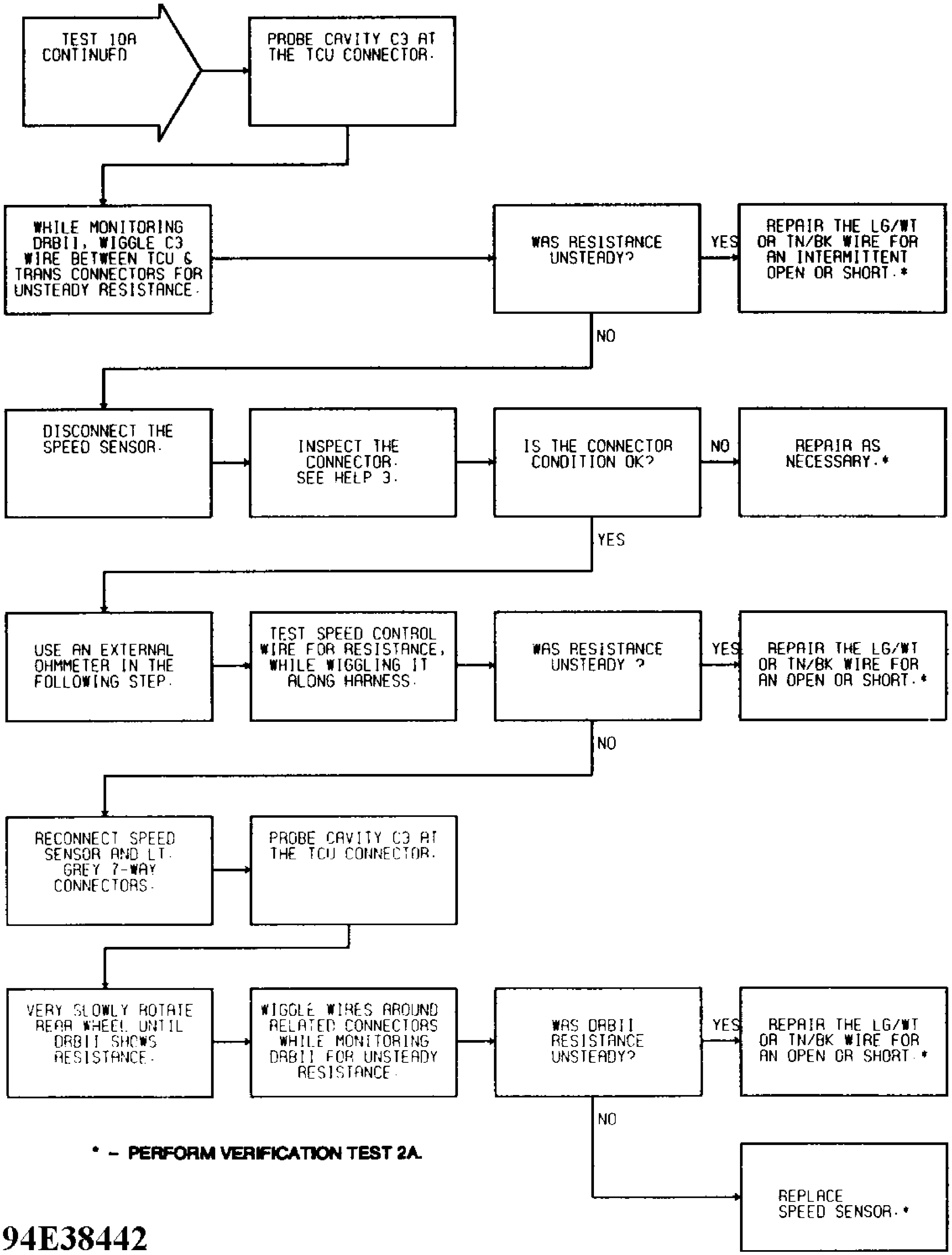


Fig. 119: Test 10A - Flow Chart (2 of 2)

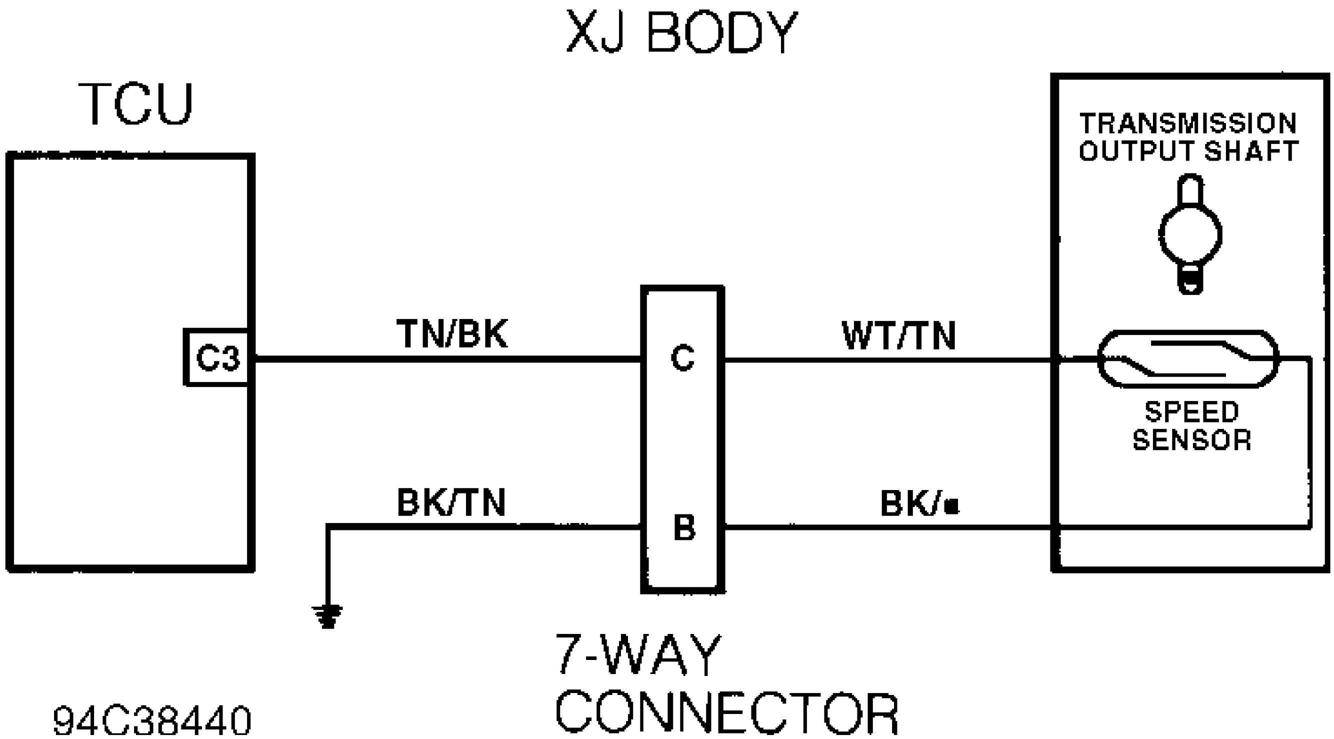


Fig. 120: Test 10A - Schematic (Cherokee)

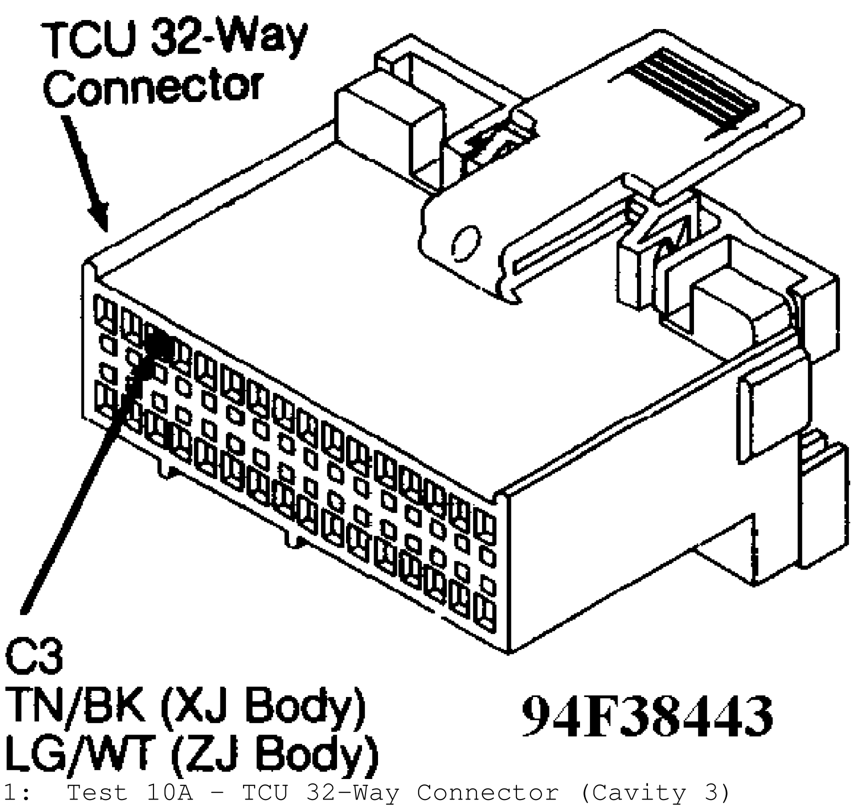


Fig. 121: Test 10A - TCU 32-Way Connector (Cavity 3)

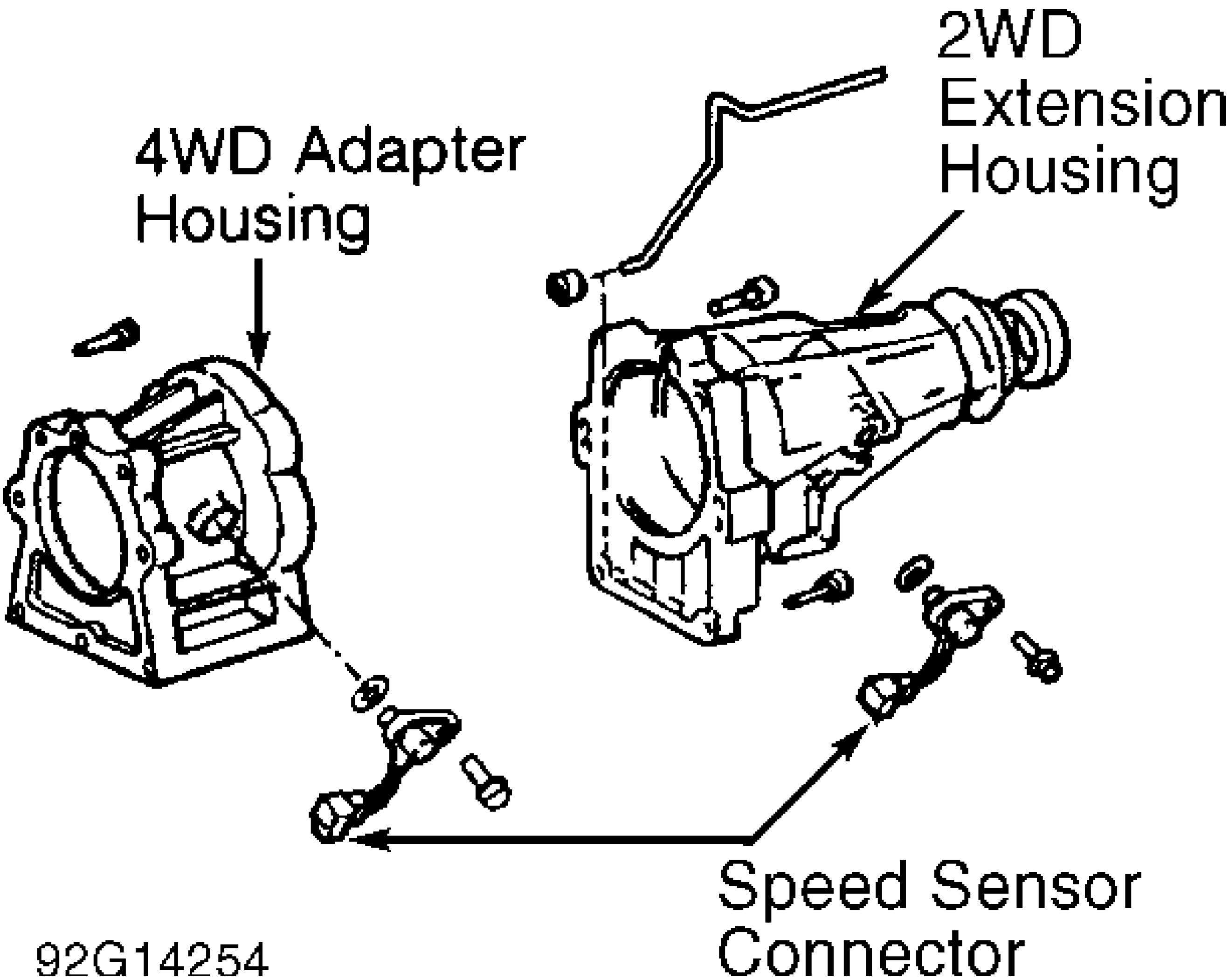


Fig. 122: Test 10A - Location of Speed Sensor Connector

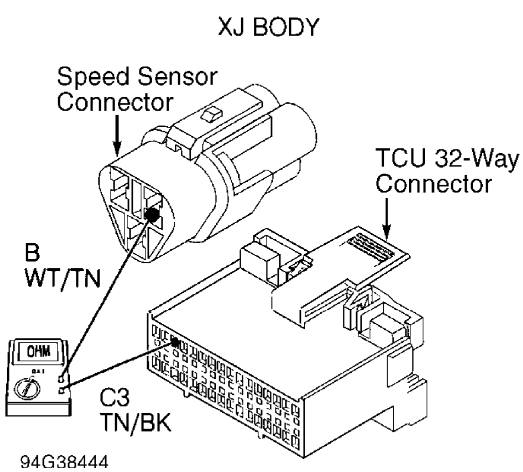


Fig. 123: Test 10A - Testing Speed Sensor (Cherokee)

WIRING DIAGRAMS

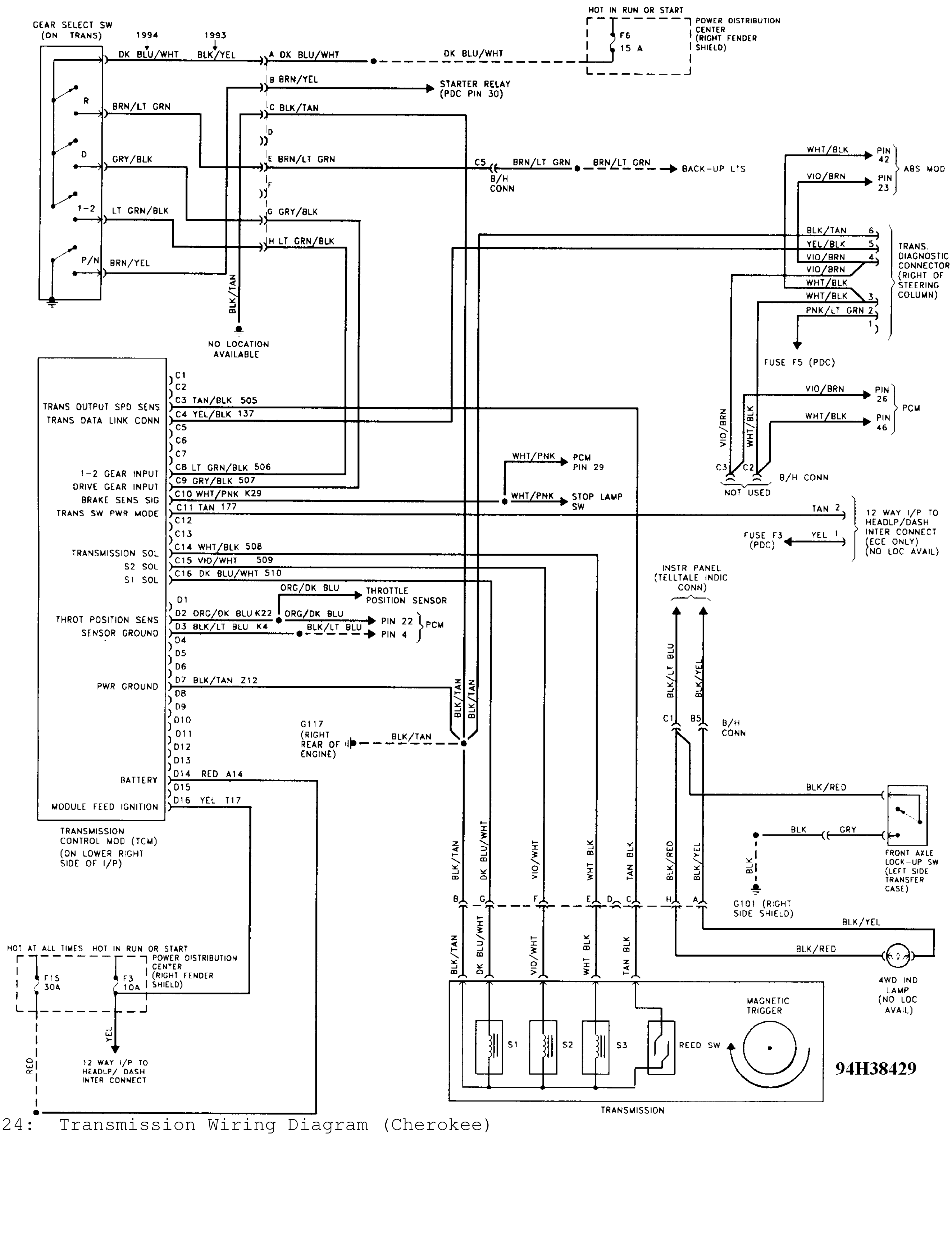
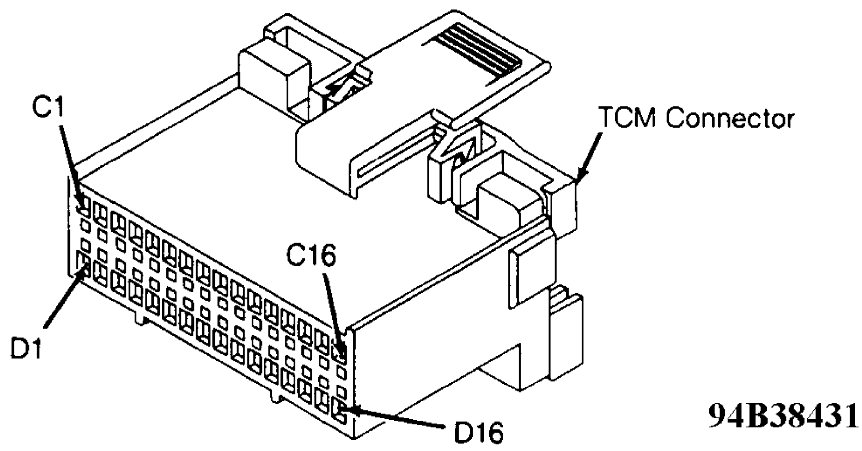


Fig. 124: Transmission Wiring Diagram (Cherokee)



CHEROKEE

CAV	CIRCUIT	FUNCTION
C1-C2		Not Used
C3	505 TN/BK	Trans Speed Sensor
C4	137 YL/BK	Auto Trans Diagnostic
C5-C7		Not Used
C8	506 LG/BK	Low (1-2) Input
C9	507 GY/BK	Drive (3) Input
C10	K29 WT/PK	Brake Input
C11		Not Used
C12-C13		Not Used
C14	508 WT/BK	S3 Solenoid (Converter Lockup)
C15	509 VT/WT	S2 Solenoid
C16	510 DB/WT	S1 Solenoid
D1		Not Used
D2	K22 OR/DB	Throttle Position Sensor
D3	K4 BK/LB	TPS Signal Ground
D4-D6		Not Used
D7	Z12 BK/TN	Power Ground
D8-D13		Not Used
D14	A14 RD	Battery
D15		Not Used
D16	T17 YL	Ignition (Run/On)

GRAND CHEROKEE

CAV	CIRCUIT	FUNCTION
C1-C2		Not Used
C3	T14 LG/WT	Trans Speed Sensor
C4	D82 BK/YL	Auto Trans Diagnostic
C5-C7		Not Used
C8	T25 LG	Low (1-2) Input
C9	T50 DG	Drive (3) Input
C10	L53 BR	Brake Input
C11-C13		Not Used
C14	T20 LB/BR	S3 Solenoid (Converter Lockup)
C15	T59 PK	S2 Solenoid
C16	T60 BR/YL	S1 Solenoid
D1		Not Used
D2	K22 OR/DB	Throttle Position Sensor
D3	K4 BK/LB	TPS Signal Ground
D4-D6		Not Used
D7	Z1 BK	Power Ground
D8-D13		Not Used
D14	A14 RD/WT	Battery
D15		Not Used
D16	F86 LB/RD	Ignition (Run/On)

Fig. 125: TCM Connector Terminals I.D., Circuits & Functions
Courtesy of Chrysler Corp.

REMOVAL & INSTALLATION

BRAKE SWITCH

Removal

Remove lower steering column cover or trim panels for access to brake switch (if necessary). Disconnect brake switch electrical connector. Thread brake switch from retainer and remove.

Installation

1) Install brake switch in retainer. Reconnect brake switch electrical connector.

2) To check brake switch adjustment, slightly depress brake pedal and note operation of brake switch plunger. Brake switch plunger should fully extend when brake pedal free play is taken up and brake application begins.

3) Clearance between brake switch plunger and brake pedal should be approximately 1/8". If clearance is not within specification, pull brake pedal rearward as far as possible.

4) Brake pedal should contact brake switch plunger, pushing brake switch backward in retainer to provide proper adjustment. Ensure brake lights operate.

5) Recheck clearance between brake switch plunger and brake pedal with brake pedal depressed and free play taken up. Reinstall lower steering column cover or trim panels.

NEUTRAL SAFETY SWITCH

NOTE: Neutral safety switch may be referred to as park/neutral or gear select switch.

Removal

1) Apply parking brake. Raise and support vehicle. Disconnect electrical connector at neutral safety switch. Pry lock washer tabs away from retaining nut. See Fig. 126.

2) Remove retaining nut, lock washer and adjusting bolt. See Fig. 126. Remove neutral safety switch from manual valve shaft.

Installation

1) Disconnect shift control rod from transmission shift lever. Rotate transmission shift lever fully rearward and then forward 2 detents to Neutral position.

2) Install neutral safety switch on manual valve shaft. Install adjusting bolt but DO NOT tighten at this time.

3) Install lock washer and retaining nut. Tighten retaining nut to specification. See TORQUE SPECIFICATIONS. DO NOT bend over lock washer tabs at this time.

4) Ensure transmission is still in Neutral. Rotate neutral safety switch and align neutral standard line with vertical groove on manual valve shaft. See Fig. 126.

5) Tighten the adjusting bolt to specification. Refer to the TORQUE SPECIFICATIONS table. Bend lock washer tabs over. Reconnect shift control rod and electrical connector. Ensure vehicle starts in Park and Neutral only.

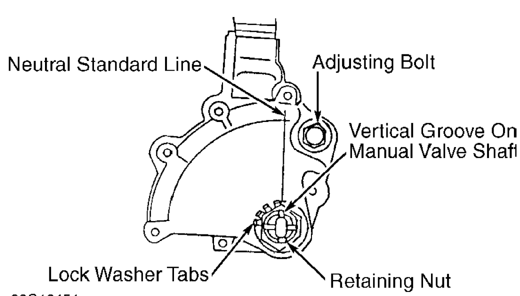


Fig. 126: Installing Neutral Safety Switch
Courtesy of Chrysler Corp.

SPEED SENSOR

Removal & Installation

1) Disconnect electrical connector at speed sensor located on adapter housing or extension housing. Remove bolt and speed sensor. Remove "O" ring from speed sensor.

2) To install, reverse removal procedure using NEW "O" ring. Tighten bolt to specification. See TORQUE SPECIFICATIONS at end of article.

THROTTLE POSITION SENSOR (TPS)

Removal & Installation

1) Note location of TPS electrical connector. See Fig. 127. Disconnect electrical connector. Remove screws and TPS.

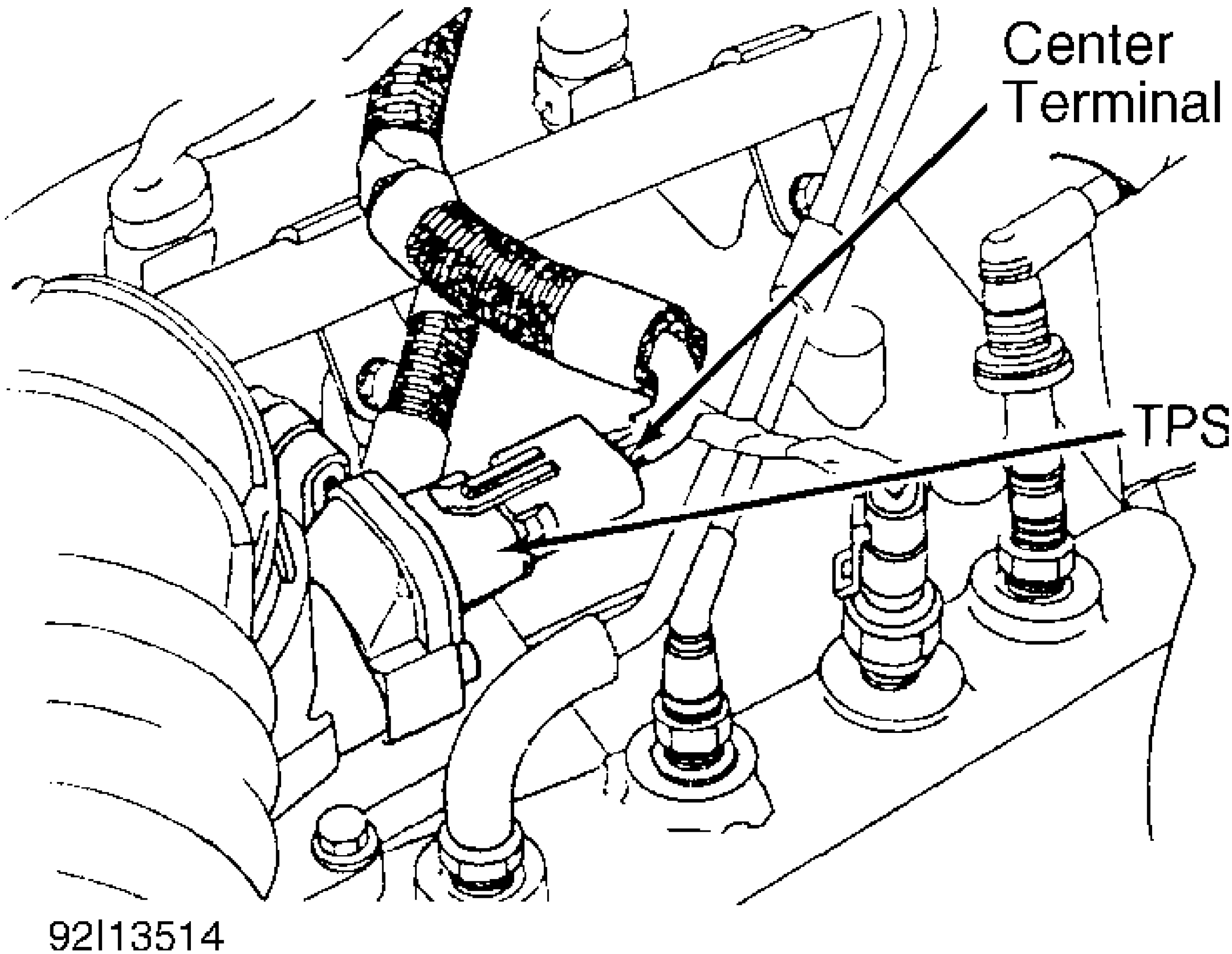


Fig. 127: Identifying TPS Electrical Connector
Courtesy of Chrysler Corp.

2) To install, reverse removal procedure. Ensure throttle shaft on throttle body engages socket tangs on TPS. See Fig. 128. Tighten screws. Manually operate throttle and ensure no binding exists. Reinstall electrical connector.

NOTE: TPS must be installed so it can be rotated a few degrees. If

TPS cannot be rotated, reinstall TPS with end of throttle shaft on other side of TPS socket tangs.

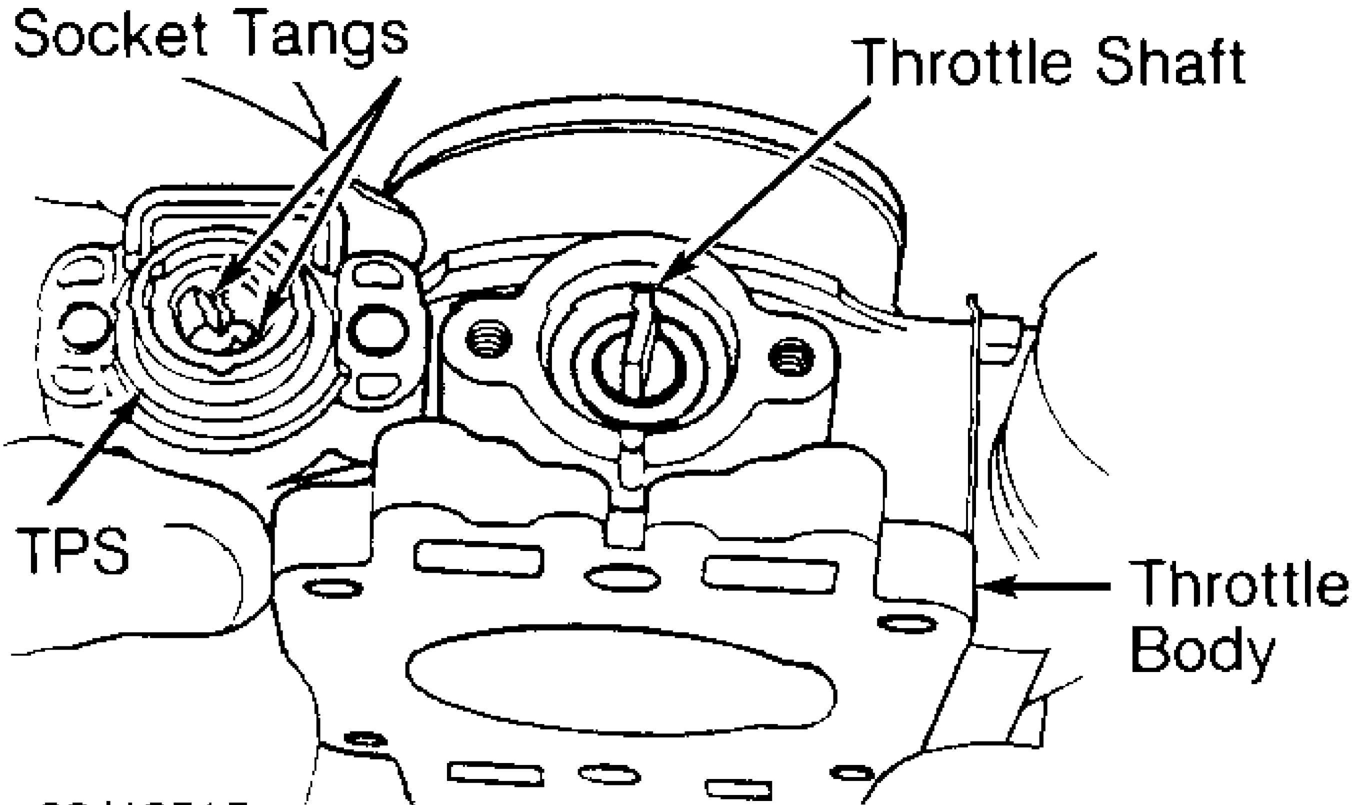


Fig. 128: Installing Throttle Position Sensor (TPS)
Courtesy of Chrysler Corp.

TRANSMISSION CONTROL MODULE (TCM)

Removal & Installation (Cherokee)

Ensure ignition is off. Disconnect electrical connector from TCM, located behind right side of instrument panel. See Fig. 129. Remove fastener and TCM from instrument panel. To install, reverse removal procedure.

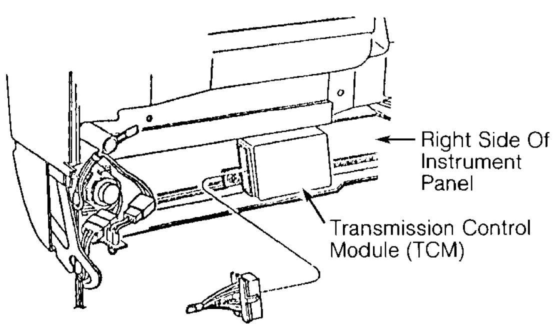


Fig. 129: Transmission Control Module (TCM) I.D. (Cherokee)
Courtesy of Chrysler Corp.

VALVE BODY SOLENOID

Removal

1) Raise and support vehicle. Remove drain plug and drain transmission fluid. Remove bolts and oil pan. Remove bolts, oil screen and gasket.

2) Disconnect electrical connectors from valve body solenoid. Mark electrical connector location for reassembly reference if more than one valve body solenoid is being removed. Remove bolt, valve body solenoid and "O" ring.

CAUTION: DO NOT allow components to fall from valve body when removing valve body solenoid.

Installation

1) To install, reverse removal procedure using NEW "O" ring and NEW gaskets. Tighten valve body solenoid bolt and oil screen bolt to specification. See TORQUE SPECIFICATIONS at end of article.

2) Ensure magnet is installed in oil pan and does not interfere with valve body oil tubes. Apply 1/8" bead of Loctite 599 sealant on oil pan mounting flange. Install oil pan. Install and tighten bolts to specification. See TORQUE SPECIFICATIONS.

3) Install NEW gasket and drain plug. Tighten drain plug to specification. See TORQUE SPECIFICATIONS at end of article. Fill transmission to proper fluid level with Mopar Dexron-IIE/Mercon ATF.

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS

Application	Ft. Lbs. (N.m)
Drain Plug	15 (20)
	INCH Lbs. (N.m)
Neutral Safety Switch Adjusting Bolt	108 (12.2)
Neutral Safety Switch Retaining Nut	61 (6.9)
Oil Pan Bolt	65 (7.3)
Oil Screen Bolt	84 (9.5)
Speed Sensor Bolt	65 (7.3)
Valve Body Solenoid Bolt	84 (9.5)

BRAKE SYSTEM BLEEDING

1988 Jeep Cherokee

1988 BRAKES
Jeep - Brake System Bleeding

Cherokee, Comanche, Grand Wagoneer, Wagoneer, Wrangler

BRAKE SYSTEM BLEEDING

Hydraulic system bleeding is necessary any time air has been introduced into system. Bleed brakes at all 4 wheels if master cylinder lines have been disconnected or master cylinder has run dry. Bleed brakes with vacuum bleeding equipment, pressure bleeding equipment or by manually pumping brake pedal while using bleeder tubes. Always bleed brake lines in sequence. See BLEEDING SEQUENCE table.

MASTER CYLINDER BLEEDING

Bench Bleeding

1) Master cylinder must be bled before installation to prevent excessive amounts of air from entering the brake system, creating poor brake operation.

2) Place master cylinder in soft-jawed vise. DO NOT tighten vise enough to damage master cylinder. Install bleeder tubes in both outlets of master cylinder. See Fig. 1.

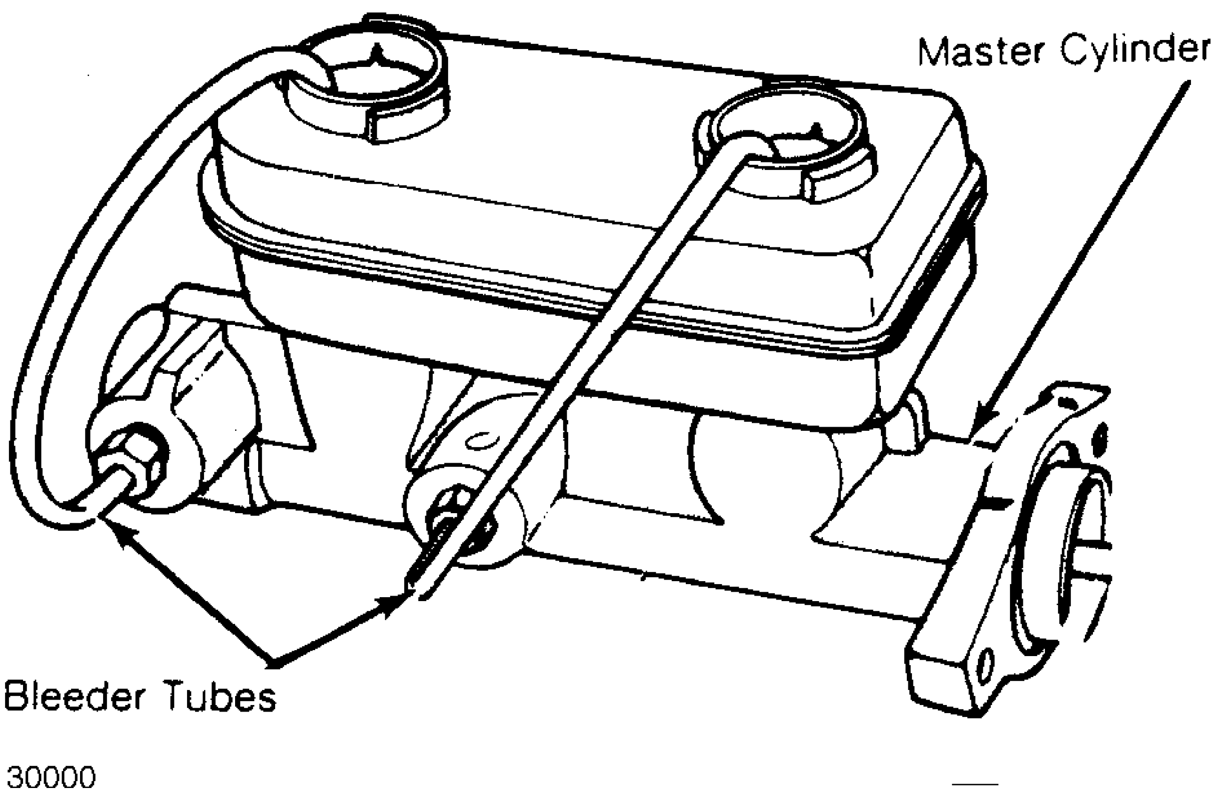


Fig. 1: Bleeding Master Cylinder
Courtesy of American Motors/Jeep Corp.

3) Fill master cylinder with clean brake fluid that meets DOT 3 specifications. Ensure that the end of bleeder tubes are submerged

in the brake fluid.

4) Using proper sized rod, apply and release master cylinder until no air bubbles exist in brake fluid flow. Once all air bubbles are gone from master cylinder secure cap and install.

5) Bleeder tubes should be left installed on master cylinder until master cylinder in installed. Master cylinder must be bled at brake lines and wheels after installation.

Bleeding On Vehicle

1) Install master cylinder on vehicle after bench bleeding. Remove bleeder lines and install brake lines. DO NOT fully tighten brake lines at this time.

2) Slowly force brake pedal to the floor and hold in this position. Tighten brake lines and release brake pedal. Repeat procedure until no air bubbles exist at brake lines. Remaining wheel cylinder or calipers may be require bleeding.

HYDRAULIC CONTROL VALVES

Hold Off Valve

1) Prior to the pressure tank bleeding procedure, the hold off valve incorporated in the combination valve must be correctly positioned. This allows brake fluid to flow through the combination valve to the entire brake system.

2) The valve stem of the hold off valve may be retained using tools available from Chrysler Motors (C-4121) or General Motors (J-23709) during bleeding procedure. See Figs. 2 and 3. Remove valve retainer once brake bleeding procedure is complete.

CAUTION: DO NOT use rigid clamp to position valve stem. Damage to the valve assembly may result causing brake failure.

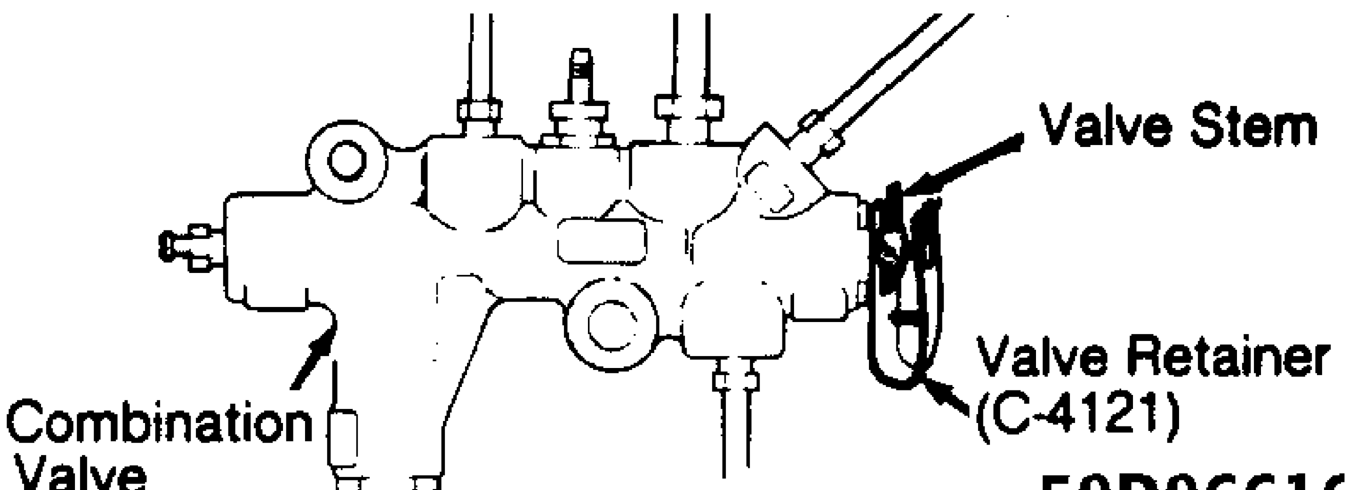
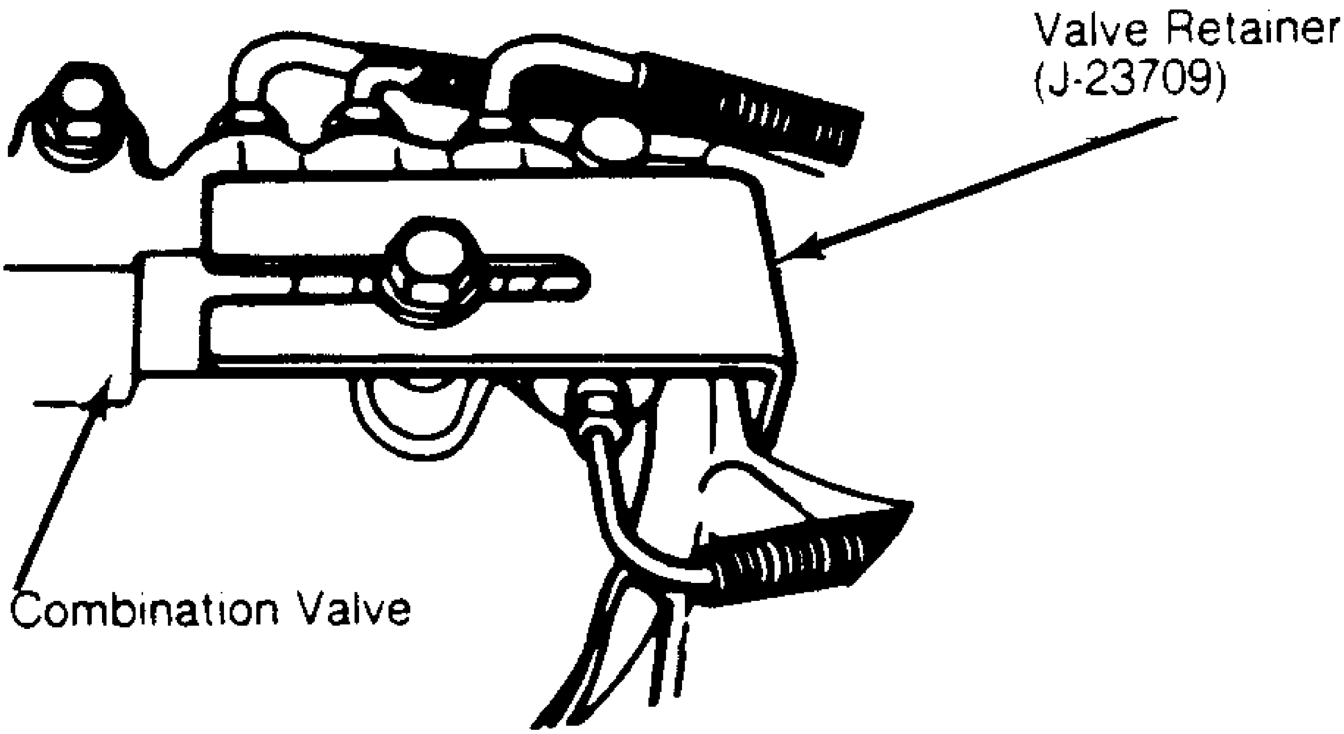


Fig. 2: Positioning Hold Off Valve
Courtesy of American Motors/Jeep Corp.



30002

Fig. 3: Positioning Hold Off Valve
Courtesy of American Motors/Jeep Corp.

VACUUM BLEEDING

Fill master cylinder. Install vacuum bleed equipment to first bleeder valve to be serviced. Open bleeder valve 3/4-1 turn. Depress vacuum pump and pull fluid into reservoir jar. Bleed each bleeder valve in sequence. See BLEEDING SEQUENCE table.

PRESSURE BLEEDING

1) Clean master cylinder cap and surrounding area. Remove cap. With pressure tank at least 1/2 full, connect to master cylinder with adapters. Attach bleeder hose to first bleeder valve to be serviced. See BLEEDING SEQUENCE table.

2) Place other end of hose in clean glass jar partially filled with clean brake fluid so end of hose is submerged in fluid. The hold off valve must be positioned properly before pressure bleeding (if equipped). See HYDRAULIC CONTROL VALVES under BRAKE SYSTEM BLEEDING in this article.

3) Open release valve on pressure bleeder. Follow equipment manufacturer's pressure instructions or see PRESSURE BLEEDER SETTINGS table. Open bleeder screw 3/4-1 turn and note fluid flow.

4) Close bleeder screw when fluid flowing is free of bubbles. Repeat procedure on remaining wheels in proper sequence. Check brake pedal operation after bleeding has been completed.

5) Remove pressure bleeding equipment and valve retainer from hold off valve. Ensure that master cylinder is full of fluid.

PRESSURE BLEEDER SETTINGS TABLE

Application	psi (kg/cm^2)

MANUAL BLEEDING

NOTE: When bleeding disc brakes, air may tend to cling to caliper walls. Lightly tap caliper, while bleeding, to aid in removal of air.

1) Fill master cylinder. Install bleeder hose to first bleeder valve to be serviced. See BLEEDING SEQUENCE table. Submerge other end of hose in clean glass jar partially filled with clean brake fluid. See Fig. 4.

2) Open bleeder valve 3/4-1 turn. Depress brake pedal slowly through full travel. Close bleeder valve and release pedal. Repeat procedure until flow of fluid shows no signs of air bubbles.

NOTE: When bleeding brake system manually, ensure bleeder valve is closed when brake pedal is released.

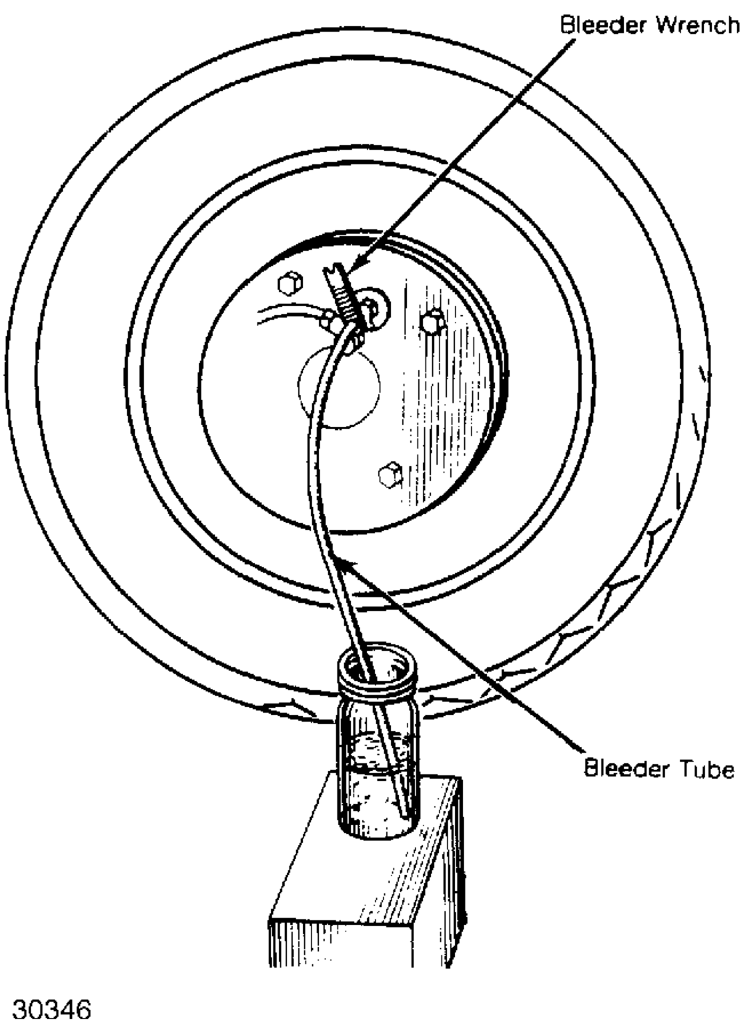


Fig. 4: Wheel Cylinder Bleeding Procedure
Courtesy of American Motors/Jeep Corp.

BLEEDING SEQUENCE

Before bleeding system, exhaust all vacuum from power unit by depressing brake pedal several times. Bleed master cylinder (if equipped) with bleeder screws. Bleed slave cylinder on vehicles equipped with remote mount power assist units. Bleed wheel cylinders and calipers in sequence. See BLEEDING SEQUENCE table.

BLEEDING SEQUENCE TABLE

Application	Sequence
All Models	RR, LR, RF, LF

* BRAKE SYSTEM UNIFORM INSPECTION GUIDELINES *

1988 Jeep Cherokee

GENERAL INFORMATION
Brake Systems - Motorist Assurance Program
Standards For Automotive Repair

All Makes & Models

CONTENTS

SHOE HARDWARE
SHOES
SOCKETS
SPEED SENSORS (ELECTRONIC WHEEL AND VEHICLE)
STEEL BRAKE LINES
STOPLIGHT SWITCHES
SWITCHES
TIRES
TOOTHED RINGS (TONE WHEEL)
VACUUM BOOSTERS
VACUUM HOSES
VALVES
WHEEL ATTACHING HARDWARE
WHEEL BEARINGS, RACES AND SEALS
WHEEL CYLINDERS
WIRING HARNESSES

INTRODUCTION TO MOTORIST ASSURANCE PROGRAM (MAP)

OVERVIEW OF MOTORIST ASSURANCE PROGRAM

The Motorist Assurance Program is the consumer outreach effort of the Automotive Maintenance and Repair Association, Inc. (AMRA). Participation in the Motorist Assurance Program is drawn from retailers, suppliers, independent repair facilities, vehicle manufacturers and industry associations.

Our organization's mission is to strengthen the relationship between the consumer and the auto repair industry. We produce materials that give motorists the information and encouragement to take greater responsibility for their vehicles-through proper, manufacturer-recommended, maintenance. We encourage participating service and repair shops (including franchisees and dealers) to adopt:

1) a Pledge of Assurance to their Customers and
2) the Motorist Assurance Program Standards of Service.

All participating service providers have agreed to subscribe to this Pledge and to adhere to the promulgated Standards of Service demonstrating to their customers that they are serious about customer satisfaction.

These Standards of Service require that an inspection of the vehicle's (problem) system be made and the results communicated to the customer according to industry standards. Given that the industry did not have such standards, the Motorist Assurance Program successfully promulgated industry inspection communication standards in 1994-95 for the following systems: Exhaust, Brakes, ABS, Steering and Suspension, Engine Maintenance and Performance, HVAC, and Electrical Systems. Further, revisions to all of these inspection communication standards are continually re-published. In addition to these, standards for Drive Train and Transmissions have recently been promulgated. Participating shops utilize these Uniform Inspection & Communication Standards as part of the inspection process and for communicating their findings to their customers.

The Motorist Assurance Program continues to work cooperatively and proactively with government agencies and consumer groups toward solutions that both benefit the customer and are mutually acceptable to both regulators and industry. We maintain the belief that industry must retain control over how we conduct our business, and we must be viewed as part of the solution and not part of the problem. Meetings with state and other government officials (and their representatives), concerned with auto repair and/or consumer protection, are conducted. Feedback from these sessions is brought back to the association, and the program adjusted as needed.

To assure auto repair customers recourse if they were not

satisfied with a repair transaction, the Motorist Assurance Program offers mediation and arbitration through MAP/BBB-CARE and other non-profit organizations. MAP conducted pilot programs in twelve states before announcing the program nationally in October, 1998. During the pilots, participating repair shops demonstrated their adherence to the Pledge and Standards and agreed to follow the UICS in communicating the results of their inspection to their customers. To put some "teeth" in the program, an accreditation requirement for shops was initiated. The requirements are stringent, and a self-policing method has been incorporated which includes the "mystery shopping" of outlets.

We welcome you to join us as we continue our outreach with your support, both the automotive repair industry and your customers will reap the benefits. Please visit MAP at our Internet site www. motorist.org or contact us at:

1444 I Street, NW Suite 700
Washington, DC 20005
Phone (202) 712-9042 Fax (202) 216-9646

January 1999

MAP UNIFORM INSPECTION GENERAL GUIDELINES

OVERVIEW OF SERVICE REQUIREMENTS AND SUGGESTIONS

It is MAP policy that all exhaust, brake, steering, suspension, wheel alignment, drive-line, engine performance and maintenance, and heating, ventilation and air conditioning, and electrical services be offered and performed under the standards and procedures specified in these sections.

Before any service is performed on a vehicle, an inspection of the appropriate system must be performed. The results of this inspection must be explained to the customer and documented on an inspection form. The condition of the vehicle and its components will indicate what services/part replacements may be "Required" or "Suggested". In addition, suggestions may be made to satisfy the requests expressed by the customer.

When a component is suggested or required to be repaired or replaced, the decision to repair or replace must be made in the customer's best interest, and at his or her choice given the options available.

This section lists the various parts and conditions that indicate a required or suggested service or part replacement. Although this list is extensive, it is not fully inclusive. In addition to this list, a technician may make a suggestion. However, any suggestions must be based on substantial and informed experience, or the vehicle manufacturer's recommended service interval and must be documented.

Some conditions indicate that service or part replacement is required because the part in question is no longer providing the function for which it is intended, does not meet a vehicle manufacturer's design specification or is missing.

Example:
An exhaust pipe has corroded severely and has a hole in it through which exhaust gases are leaking. Replacement of the exhaust pipe in this case is required due to functional failure.

Example:
A brake rotor has been worn to the point where it measures less than the vehicle manufacturer's discard specifications.

Replacement of the rotor is required because it does not meet design specifications.

Some conditions indicate that a service or part replacement is suggested because the part is close to the end of its useful life or addresses a customer's need, convenience or request. If a customer's vehicle has one of these conditions, the procedure may be only to suggest service.

Example:
An exhaust pipe is rusted, corroded or weak, but no leaks are present. In this case, the exhaust pipe has not failed. However, there is evidence that the pipe may need replacement in the near future. Replacement of the pipe may be suggested for the customer's convenience in avoiding a future problem.

Example:
The customer desires improved ride and/or handling, but the vehicle's shocks or struts have not failed. In this case, replacement may be suggested to satisfy the customer's wishes. In this case, replacement of the shocks or struts may not be sold as a requirement.

A customer, of course, has the choice of whether or not a shop will service his or her vehicle. He or she may decide not to follow some of your suggestions. When a repair is required, a MAP shop must refuse partial service on that system if, in the judgment of the service provider, proceeding with the work could create or continue an unsafe condition. When a procedure states that required or suggested repair or replacement is recommended, the customer must be informed of the generally acceptable repair/replacement options whether or not performed by the shop.

When presenting suggested repairs to the customer, you must present the facts, allowing the customer to draw their own conclusions and make an informed decision about how to proceed.

The following reasons may be used for required and suggested services. These codes are shown in the "Code" column of the MAP Uniform Inspection & Communications Standards that follow:

Reasons to Require Repair or Replacement
A – Part no longer performs intended purpose
B – Part does not meet a design specification (regardless of performance)
C – Part is missing

NOTE: When a repair is required, the shop must refuse partial service to the system in question, if the repair creates or continues an unsafe condition.

Reasons to Suggest Repair or Replacement
1 – Part is close to the end of its useful life (just above discard specifications, or weak; failure likely to occur soon, etc.)
2 – To address a customer need, convenience, or request (to stiffen ride, enhance performance, eliminate noise, etc.)
3 – To comply with maintenance recommended by the vehicle's Original Equipment Manufacturer (OEM)
4 – Technician's recommendation based on substantial and informed experience

NOTE: Suggested services are always optional. When presenting suggested repairs to the customer, you must present the facts, allowing the customer to draw their own conclusions

and make an informed decision about how to proceed.

BRAKES

SERVICE PROCEDURES REQUIRED & SUGGESTED FOR PROPER VEHICLE OPERATION

Some states may have specifications that differ from OEM. Check your local/state regulations. Where state or local laws are stricter, they take precedence over these guidelines.

ACCELEROMETERS (G SENSOR OR LATERAL)

ACCELEROMETER INSPECTION

Condition	Code	Procedure
Broken	A	Require replacement.
Connector loose	A	Require repair or replacement.
Loose	B	Require repair or replacement.
Missing	C	Require replacement.
Out of position	B	Require re-positioning to vehicle manufacturer's specifications.
Output signal incorrect	B	Require replacement.

ACCUMULATORS

ACCUMULATOR INSPECTION

Condition	Code	Procedure
Leaking	B	Require replacement.
Missing	C	Require replacement.
Pre-charge incorrect	B	Require replacement.

ANCHOR PINS

See BACKING PLATES.

ANTI-LOCK BRAKE SYSTEMS

NOTE: Anti-lock brakes are an integral part of the brake system. It is essential that the anti-lock brakes function properly when brake service is performed.

Anti-lock brake systems are commonly referred to as "ABS" and will be referred to as "ABS" throughout these guidelines. Some ABS components also function as part of a traction control system (TCS).

WARNING: When diagnosing and servicing high pressure components, observe safety procedures and equipment requirements established by the vehicle manufacturer to reduce the possibility of serious personal injury.

NOTE: Intermittent electrical conditions are often caused by a loss of ground, poor connection, or water intrusion into the wiring harness.

NOTE: Electro-magnetic interference (EMI) may be caused by incorrect installation of accessories or components. EMI can result in improper system operation.

BACKING PLATES

BACKING PLATE INSPECTION

Condition	Code	Procedure
Anchor pin bent	B	Require repair or replacement.
Anchor pin broken	A	Require replacement.
Anchor pin worn, affecting structural integrity	B	Require replacement.
Backing plate bent	B	Require repair or replacement.
Backing plate broken	A	Require replacement.
Backing plate cracked	B	Require repair or replacement.
Corroded, affecting structural integrity	A	Require replacement.
Loose	B	Require repair or replacement.
Missing	C	Require replacement.
Shoe lands worn	A	Require repair or replacement.

BRAKE FLUID

CAUTION: Most manufacturers prohibit the use of DOT 5 brake fluid in a system equipped with ABS.

DOT 3, DOT 4, and DOT 5.1 brake fluids are clear or light amber in color. DOT 5 brake fluid is violet in color. Correct fluid required for the brake system is stamped on the master cylinder cover.

BRAKE FLUID INSPECTION

Condition	Code	Procedure
Beyond service interval	3	Suggest flushing and refilling with correct fluid.
Brake fluid type incorrect	B	Require flushing and refilling with correct fluid.
Contaminated, for example, fluid other than brake fluid present	A or B	(1) Require service.
Hydraulic component overhaul or replacement	3	Suggest flushing and refilling with correct fluid.
Rubber master cylinder cover gasket distorted and gummy	A	(2) Require replacement of gasket.

(1) - If a fluid other than brake fluid is present in the brake system which DOES affect the rubber parts, the required service is to:

* Remove all components having rubber parts from the system.
* Flush lines with denatured alcohol or brake cleaner
* Repair or replace all components having rubber parts
* Flush and fill with correct brake fluid. (Code A)

If a fluid other than brake fluid is present in the brake

system which DOES NOT affect the rubber parts, the required service is to flush and fill with the correct brake fluid. (Code B)

(2) - This condition may indicate contaminated brake fluid.

BRAKE FRICTION MATERIAL

See FRICTION MATERIAL.

BRAKE PADS

See FRICTION MATERIAL.

BRAKE PEDALS

BRAKE PEDAL INSPECTION

Condition	Code	Procedure
Bent, affecting performance	A	Require repair or replacement.
Broken	A	Require repair or replacement.
Pedal pad missing	C	Require replacement of pedal pad.
Pedal pad worn	1	Suggest replacement.
Pivot bushings worn, affecting performance	A	Require replacement of pivot bushings.

BRAKE SHOES

See FRICTION MATERIAL.

BRAKE SHOE HARDWARE

See also SELF-ADJUSTING SYSTEMS.

BRAKE SHOE HARDWARE INSPECTION

Condition	Code	Procedure
Broken	A	Require replacement.
Distorted	A	Require replacement.
Missing	C	Require replacement.
Surfaces rust-pitted	1	Suggest replacement.
Worn, affecting performance	A	Require replacement.

BRAKE STOPLIGHT SWITCHES

BRAKE STOPLIGHT INSPECTION

Condition	Code	Procedure
Bent	B	Require replacement.
Broken	A	Require replacement.
Connector broken	A	Require repair or replacement.
Connector (Weatherpack type) leaking	A	Require repair or replacement.

Connector melted	A	(1) Require replacement.
Connector missing	C	Require replacement.
Missing	C	Require replacement.
Out of adjustment	B	Require adjustment or replacement.
Output signal incorrect	B	Require replacement.
Terminal burned, affecting performance	A	(2) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.

(1) - Determine cause and correct prior to replacement of part.
(2) - Determine cause and correct prior to repair or replacement of part.

BULB SOCKETS

BULB SOCKET INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Broken	A	Require repair or replacement.
Bulb seized in socket	A	Require repair or replacement.
Burned, affecting performance	A	(1) Require repair or replacement.
Burned, not affecting performance	2	(1) Suggest repair or replacement.
Connector broken	A	Require repair or replacement.
Connector missing	C	Require replacement.
Connector (Weatherpack type) leaking	A	Require repair or replacement.
Connector melted	A	(2) Require repair or replacement.
Corroded, affecting performance	A	Require repair or replacement.
Corroded, not affecting performance	2	Suggest repair or replacement.
Leaking	A	Require repair or replacement.
Melted	A	(2) Require replacement.

Shorted	A	Require repair or replacement.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(2) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of socket.
(2) - Determine cause and correct prior to repair or replacement of part.

BULBS AND LEDS

NOTE: Copied from Electrical UIGs and modified. Does not include soldered-in components.

BULB AND LED INSPECTION

Condition	Code	Procedure
Application incorrect	B	(1) Require replacement.
Base burned, affecting performance	A	(2) Require repair or replacement.
Base burned, not affecting performance	2	(2) Suggest repair or replacement.
Base corroded, affecting performance	A	Require repair or replacement.
Base corroded, not affecting performance	2	Suggest repair or replacement.
Base loose, affecting performance	B	Require repair or replacement.
Base loose, not affecting performance	1	Suggest repair or replacement.
Burned out	A	Require replacement.
Intermittent	A	Require replacement.
Missing	C	Require replacement.
Seized in socket	A	Require repair or replacement.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(2) Require repair or replacement.
Terminal burned, not affecting performance	2	(2) Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.

Terminal loose, not affecting performance	1	Suggest repair or replacement.

(1) - Application incorrect includes wrong bulb coating or color.
(2) - Determine cause and correct prior to repair or replacement of part.

CALIPER HARDWARE

CALIPER HARDWARE INSPECTION

Condition	Code	Procedure
Bent	A	Require repair or replacement.
Broken	A	Require repair or replacement.
Corroded, affecting performance	A	Require repair or replacement.
Dust boots on slider pin (bolt) missing	C	Require replacement of boots.
Dust boots on slider pin (bolt) torn	A	Require replacement of boots.
Missing	C	Require replacement.
Shim bent	A	(1) Require removal or replacement.
Shim (OE standard) missing	C	(2) Require replacement.
Shim out of position	B	(1) Require removal or replacement.
Shim worn	A	(1) Require removal or replacement.
Slider pin (bolt) bent	B	Require replacement of slider pin or bolt and lubricants.
Slider pin (bolt) rust-pitted	A	Require replacement of slider pin or bolt and lubricants.
Slider pin (bolt) worn	A	Require replacement of slider pin or bolt and lubricants.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.
Worn, affecting performance	A	Require replacement.

(1) - Removal is acceptable if shim is not OE.
(2) - Aftermarket shims may be suggested to reduce noise.

CALIPERS

You are not required to replace or rebuild calipers in axle sets. However, when replacing or rebuilding a caliper due to the conditions that follow, you may suggest servicing, rebuilding, or replacement of the other caliper (on the same axle) for improved performance and preventive maintenance (for example, the part is close to the end of its useful life, replacing the caliper may extend pad life, or contribute to more balanced braking).

CAUTION: When installing loaded calipers, it is required that friction material be matched in axle sets for consistent braking characteristics.

CALIPER INSPECTION

Condition	Code	Procedure
Bleeder port damaged	A	... Require repair or replacement of caliper.
Bleeder screw broken off in caliper	A	.... (1) Require repair or replacement of caliper.
Bleeder screw plugged ...	A	.... (1) Require repair or replacement of bleeder screw.
Bleeder screw seized	A	.... (2) Require replacement of caliper.
Casting corroded, affecting structural integrity	A	.... Require replacement.
Casting damaged, affecting structural integrity ...	A	.... Require replacement.
Dust boot around caliper torn	A	..... Require replacement of dust boot.
Leaking	A	.. Require repair or replacement.
Mounting pin threads damaged	A	... Require repair or replacement of component with damaged threads.
Mounting pin threads stripped in caliper bracket (threads missing)	A	... Require repair or replacement of caliper bracket.
Mounting pin threads stripped in steering knuckle (threads missing)	A	... Require repair or replacement of steering knuckle.
Mounting pin threads stripped (threads missing)	A	... Require repair or replacement of component with stripped threads.
Parking brake cable support, lever, or return spring bent	A	... Require replacement of parts.
Parking brake cable support, lever, or return spring broken	A	... Require replacement of parts.
Parking brake mechanism in caliper inoperative	A	.. Require repair or replacement.
Piston corroded (pitted or peeling chrome plating)	B	... Require replacement of piston and rebuilding or replacement of caliper.
Piston damaged, affecting performance	B	... Require replacement of piston and rebuilding or replacement of caliper.
Piston damaged, not affecting performance ..	..	.... No service suggested or required.
Piston finish worn off ..	B	... Require replacement of piston and rebuilding or replacement

Condition	Code	Procedure
		of caliper.
Piston sticking	A	Require rebuilding or replacement of caliper.
Slide mechanism sticking	A	Require repair or replacement of slide mechanism.

(1) - Only required if the hydraulic system must be opened.
(2) - Seized is defined as a bleeder screw that cannot be removed after a practical attempt at removing. Only required if the hydraulic system must be opened.

CONTROLLERS

See ELECTRONIC CONTROLLERS.

DIGITAL RATIO AXLE CONTROLLERS AND BUFFERS (DRAC AND DRAB)

DIGITAL RATIO AXLE CONTROLLER AND BUFFER INSPECTION

Condition	Code	Procedure
Connector broken	A	Require repair or replacement.
Connector (Weatherpack type) leaking	A	Require repair or replacement.
Connector melted	A	(1) Require replacement.
Connector missing	C	Require replacement.
Missing	C	Require replacement.
Output signal incorrect	B	Require repair or replacement.
Terminal burned, affecting performance	A	(2) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.

(1) - Determine cause and correct prior to replacement of part.
(2) - Determine cause and correct prior to repair or replacement of part.

DISABLE SWITCHES

See SWITCHES.

DRUMS

Determine the need to recondition based upon individual drum conditions that follow. Friction material replacement does not require drum reconditioning unless other justifications exist. DO NOT recondition new drums unless they are being pressed or bolted onto an existing hub. It is not necessary to replace drums in axle sets. However, when replacing or reconditioning a drum due to the conditions that follow, you may suggest reconditioning of the other drum on the

same axle to eliminate uneven braking behavior. Always wash drums after servicing or before installing.

DRUM INSPECTION

Condition	Code	Procedure
Balance weight missing	..	No service suggested or required.
Bell-mouthed, affecting performance	A	Require reconditioning or replacement.
Cooling fin broken	..	No service suggested or required.
Cracked	B	Require replacement.
Drum diameter is greater than OEM "machine to" specifications but less than "discard at" specifications, and the drum does not require reconditioning	1	(1) Suggest replacement.
Drum diameter will exceed OEM "machine to" specifications after required reconditioning	B	(2) Require replacement.
Hard-spotted	2	Suggest reconditioning or replacement.
Measured diameter is greater than OEM discard specifications	B	Require replacement.
Out-of-round (runout), affecting performance	A	Require reconditioning or replacement.
Out-of-round (runout), exceeding manufacturer's specifications	B	Require reconditioning or replacement.
Scored	B	Require reconditioning or replacement.
Surface threaded due to improper machining	B	Require reconditioning or replacement.
Tapered, affecting performance	A	Require reconditioning or replacement.

(1) - Only applies to vehicles for which OEM "machine to" specifications exist. If OEM does not supply "machine to" specifications, the drum may be worn to discard specifications.
(2) - If OEM does not supply "machine to" specifications, you may machine to discard specifications.

ELECTRICAL PUMPS AND MOTORS

Copied fuel pump conditions from engine UIGs & deleted pulsator from leaking conditions.

ELECTRICAL PUMP AND MOTOR INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Connector broken	A	Require repair or replacement.
Connector (Weatherpack type) leaking	A	Require repair or replacement.
Connector melted	A	(1) Require repair or replacement.
Connector missing	C	Require replacement.
Contaminated	A	(2) Require replacement.
Inoperative	A	(3) Require repair or replacement.
Leaking externally	A	Require repair or replacement.
Leaking internally	A	Require repair or replacement.
Noisy	2	Suggest repair or replacement.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(1) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.
Wire lead conductors exposed	B	Require repair or replacement.
Wire lead corroded	A	Require repair or replacement.
Wire lead open	A	Require repair or replacement.
Wire lead shorted	A	Require repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - Determine source of contamination. Require repair or replacement.
(3) - Inoperative includes intermittent operation or out of OEM specifications.

ELECTRONIC CONTROLLERS

ELECTRONIC CONTROLLER INSPECTION

Condition	Code	Procedure
Application incorrect	B	Require replacement.
Attaching hardware missing	C	Require replacement of

		hardware.
Attaching hardware threads damaged	A	Require repair or replacement of hardware.
Attaching hardware threads stripped (threads missing)	A	Require repair or replacement of hardware.
Code set (if applicable)	A	(1) Further inspection required.
Connector broken	A	Require repair or replacement.
Connector melted	A	(2) Require repair or replacement.
Connector missing	A	Require repair.
Contaminated	A	Require repair or replacement.
Inoperative	B	Require repair or replacement. (3) Further inspection required.
Leaking	A	Require repair or replacement.
Missing	C	Require replacement.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(2) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.
Wire lead conductors exposed	B	Require repair or replacement.
Wire lead corroded	A	Require repair or replacement.
Wire lead open	A	Require repair or replacement.
Wire lead shorted	A	Require repair or replacement.

(1) - Refer to manufacturer's diagnostic trouble code procedure and require repair or replacement of affected component(s).
(2) - Determine cause and correct prior to repair or replacement of part.
(3) - Inoperative includes intermittent operation or out of OEM specification. Some components may be serviceable. Check for accepted cleaning procedure.

FLUID

See BRAKE FLUID.

FLUID LEVEL SENSOR SWITCHES

See SWITCHES.

FOUR WHEEL DRIVE SWITCHES

See SWITCHES.

FRICTION MATERIAL

NOTE: Original Equipment Manufacturer (OEM) specifications designate replacement at different thicknesses.

CAUTION: It is required that friction material be matched in axle sets for consistent braking characteristics.

FRICTION MATERIAL INSPECTION

Condition	Code	Procedure
Contaminated, for example, fluid that leaked from caliper, wheel cylinder, or axle seal	A	(1) Require replacement.
Cracked through	B	Require replacement.
Flaking or chunking	B	Require replacement.
Glazed (shiny)	..	No service suggested or required.
Grooves or ridges	..	(2) No service suggested or required.
Permanently attached hardware bent	A	Require replacement.
Permanently attached hardware broken	A	Require replacement.
Permanently attached hardware loose	A	Require replacement.
Permanently attached hardware missing	C	Require replacement.
Permanently attached hardware seized	A	Require repair or replacement.
Rivets loose	B	Require replacement.
Separating from backing	B	Require replacement.
Shoe table or web bent	B	Require replacement.
Shoe table or web cracked	A	Require replacement.
Shoe table or web worn, affecting performance	A	Require replacement.
Surface cracking	..	No service suggested or required. Further inspection may be necessary to determine cause.
Tapered wear	B	(3) Suggest replacement.
Thickness of one pad is greater than opposite pad in the same caliper (uneven wear)	..	(4) Replacement of friction material not suggested or required. Further inspection required. See CALIPERS and CALIPER HARDWARE.
Wear indicator device (electronic) contacts rotor	B	(5) Require replacement of appropriate parts.
Wear indicator device (mechanical) bent	..	(6) Further inspection required.
Wear indicator device (mechanical) broken	..	(6) Further inspection required.

Wear indicator device (mechanical) contacts rotor		(6) Further inspection required.
Worn close to minimum specifications	1	(7) Suggest replacement.
Worn to, or below minimum specifications	B	Require replacement.

(1) - Identify and repair cause of contamination prior to replacing friction material.
(2) - When reconditioning or replacing drums or rotors, replacement of friction material may be suggested depending on the severity of the grooves or ridges.
(3) - Some vehicles use pads that are tapered by design. Refer to specific vehicle application. If not normal, require replacement of pads and correction of cause.
(4) - Uneven pad thickness is normal on some vehicles. Refer to specific vehicle applications.
(5) - The pad wear indicator light may come on due to other electrical problems.
(6) - Explain to the customer that the purpose of the wear indicator is to alert him or her to check for friction wear. Wear indicators may be bent or broken. Therefore, the friction material must be measured. The need for friction material replacement is determined based upon the conditions stated in this section. Periodic inspection is suggested.
(7) - When the part appears to be close to the end of its useful life, replacement may be suggested.

G SENSORS

See ACCELEROMETERS.

HOSES

HOSE INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Blistered	B	Require replacement.
Fitting threads damaged	A	Require repair or replacement.
Fitting threads stripped (threads missing)	A	Require replacement.
Incorrectly secured	B	Require repair.
Inner fabric (webbing) cut	B	Require replacement.
Leaking	A	Require replacement.
Missing	C	Require replacement.
Outer covering is cracked to the extent that inner fabric of hose		

is visible	B	Require replacement.
Restricted	A	Require replacement.
Routed incorrectly	B	Require repair.

HYDRAULIC MODULATORS

NOTE: Many modulators can only be replaced as complete assemblies. Whenever possible, replace the failed component part. If replacement of the failed part is not possible, then replace the modulator assembly.

HYDRAULIC MODULATOR INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Connector broken	A	Require repair or replacement.
Connector (Weatherpack type) leaking	A	Require repair or replacement.
Connector melted	A	(1) Require replacement.
Connector missing	C	Require replacement.
Disabled	A	Require repair or replacement.
Electrical failure	A	Require repair or replacement.
External leak	A	Require repair or replacement.
Housing cracked	B	Require repair or replacement.
Inoperative (2)	A	Require repair or replacement.
Internal leak	A	Require repair or replacement.
Missing	C	Require replacement.
Terminal burned, affecting performance	A	(1) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.
Valve stuck	A	Require repair or replacement.
Wire lead burned	A	Require repair or replacement.
Wire lead conductors exposed	B	Require repair or replacement.
Wire lead open	A	Require repair or replacement.
Wire lead shorted	A	Require repair or replacement.

(1) - Determine cause and correct prior to replacement of part.
(2) - Inoperative includes intermittent operation or out of OEM specification.

HYDRO-BOOSTERS

NOTE: Hydro-boosters and hydro-electric boosters are combined.

HYDRO-BOOSTER INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Connector broken	A	Require repair or replacement.
Connector (Weatherpack type) leaking	A	Require repair or replacement.
Connector melted	A	(1) Require replacement.
Connector missing	C	Require replacement.
Does not apply assist, or inadequate assist	A	Require repair or replacement.
Leaking	B	Require repair or replacement.
Leaks fluid at fitting	B	Require tightening or replacement.
Leaks fluid at unit	B	Require repair or replacement.
Leaks fluid from pressure hose(s)	B	Require replacement of hose(s).
Leaks fluid into passenger compartment	B	Require repair or replacement.
Threads damaged	A	Require repair or replacement.
Terminal burned, affecting performance	A	(1) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.
Threads stripped (threads missing)	A	Require replacement.

(1) - Determine cause and correct prior to replacement of part.

HYDRO-ELECTRIC BOOSTERS (POWERMASTER)

See HYDRO-BOOSTERS.

IGNITION DISABLE SWITCHES

See SWITCHES.

LATERAL ACCELERATION SWITCHES

See ACCELEROMETERS.

LEDS

See BULBS AND LEDS.

LENSES

LENSE INSPECTION

Condition	Code	Procedure
Application incorrect	A	Require replacement.
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Broken, affecting performance	A	Require replacement.
Broken, not affecting performance	..	No service suggested or required.
Cracked	A	Require replacement.
Discolored	A	Require replacement.
Leaking	A	Require repair or replacement.
Melted, affecting performance	A	Require replacement.
Melted, not affecting performance	2	Suggest replacement.
Missing	C	Require replacement.

MASTER CYLINDERS

MASTER CYLINDER INSPECTION

Condition	Code	Procedure
Brake fluid leaking from rear of master cylinder bore	B	Require repair or replacement.
Brake pedal drops intermittently	A	(1) Require repair or replacement.
Fluid level low	..	(2) Further inspection required.
Internal valve failure	A	Require repair or replacement.
Master cylinder leaking brake fluid internally	A	Require repair or replacement.
Piston does not return	A	Require repair or replacement.
Ports plugged	A	Require repair or replacement.
Rubber master cylinder cover gasket distorted and gummy	A	(3) Require replacement of the gasket.

(1) - This condition may be normal on some vehicles equipped with anti-lock brakes.
(2) - Refer to OEM procedures for adjusting low fluid level. Inspect for brake hydraulic system leaks and friction material wear.
(3) - This condition may indicate contaminated brake fluid. See BRAKE FLUID.

MODULATORS

See HYDRAULIC MODULATORS.

MOTORS

See ELECTRICAL PUMPS AND MOTORS.

PARKING BRAKE SWITCHES

See SWITCHES.

PARKING BRAKE SYSTEMS

NOTE: The parking brake is an integral part of the brake system. It is important that the parking brake function properly when brake service is performed.

PARKING BRAKE SYSTEM INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Cable improperly adjusted	B	Require cable adjustment.
Cable or individual wires in the cable are broken	A	Require replacement of cable assembly.
Cable sticking	A	Require cable lubrication.
Cable stuck inside conduit and cannot be lubricated so that parking brake functions properly	A	Require replacement of cable assembly.
Inoperative (1)	A	Require replacement of inoperative parts.
Parking brake parts bent	B	Require repair or replacement of bent parts.
Parking brake parts broken	A	Require replacement of broken parts.
Parking brake parts		

missing	C	.. Require replacement of missing parts.
Threads damaged	A	.. Require repair or replacement.
Threads stripped (threads missing)	A	.... Require replacement.

(1) - Inoperative includes intermittent operation.

PADS

See FRICTION MATERIAL.

PEDAL TRAVEL SWITCHES

See SWITCHES.

PEDALS

See BRAKE PEDALS.

POWERMASTER

See HYDRO-BOOSTERS.

PUMPS

See ELECTRICAL PUMPS AND MOTORS.

PRESSURE DIFFERENTIAL SWITCHES

See SWITCHES.

PRESSURE SWITCHES

See SWITCHES.

RELAYS

NOTE: Copied from Electrical UIGs

RELAY INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	... Require repair or replacement of hardware.
Attaching hardware missing	C	.... Require replacement of hardware.
Attaching hardware not functioning	A	... Require repair or replacement of hardware.
Housing broken	A	.... Require replacement.
Housing cracked	2	.... Suggest replacement.
Inoperative (1)	A	.... Require replacement.
Missing	C	.... Require replacement.
Terminal broken	A	.. Require repair or replacement.
Terminal burned, affecting performance ..	A	.... (2) Require repair or replacement.

Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.

(1) - Inoperative includes intermittent operation or out of OEM specification.
(2) - Determine cause and correct prior to repair or replacement of part.

ROTORS

Determine the need to recondition based upon individual rotor conditions that follow. Friction material replacement does not require rotor reconditioning unless other justifications exist. DO NOT recondition new rotors unless they are being pressed or bolted onto an existing hub. It is not necessary to replace rotors in axle sets. However, when replacing or reconditioning a rotor due to the conditions that follow, you may suggest reconditioning of the other rotor on the same axle to eliminate uneven braking behavior.

Determine the need to replace based upon the individual rotor conditions that follow. Reconditioning is defined as machining and block sanding, or block sanding only. Block sanding is defined as using 120-150 grit sandpaper with moderate to heavy force for 60 seconds per side. Always wash rotors after servicing or before installing.

ROTOR INSPECTION

Condition	Code	Procedure
Corrosion affecting structural integrity	A	(1) Require replacement.
Cracked	B	Require replacement.
Hard spots	2	Suggest reconditioning or replacement of rotor according to OEM specifications.
Lateral runout (wobble) exceeds OEM specifications	B	Require re-indexing, reconditioning, or replacement according to specifications.
Measured thickness is less than OEM discard specifications	B	Require replacement.
Rotor thickness is less than OEM "machine to" specifications but thicker than "discard at" specifications, and the rotor does not require reconditioning	1	(2) Suggest replacement.
Rotor thickness will be less than OEM "machine to" specifications after required		

reconditioning	B	(3) Require replacement.
Surface is rust-pitted	B	Require reconditioning or replacement of rotor according to OEM specifications.
Surface is scored	B	(4) Require reconditioning or replacement of rotor according to OEM specifications.
Thickness variation (parallelism) exceeds OEM specifications	B	Require reconditioning or replacement of rotor according to OEM specifications.

(1) - Examples of severe corrosion are: composite plate separated from friction surfaces and cooling fins cracked or missing.
(2) - Only applies to vehicles for which OEM "machine to" specifications exist. If OEM does not supply "machine to" specifications, the rotor may be worn to discard specifications.
(3) - If OEM does not supply "machine to" specifications, you may machine to discard specifications.
(4) - Scoring is defined as grooves or ridges in the friction contact surface. Some vehicle manufacturers require machining when scoring exceeds their allowable specifications.

SELF-ADJUSTING SYSTEMS

SELF-ADJUSTING SYSTEM INSPECTION

Condition	Code	Procedure
Bent	A	Require repair or replacement of bent part.
Broken	A	Require repair or replacement of broken part.
Inoperative	A	(1) Require repair or replacement of inoperative parts.
Missing	C	Require replacement of missing part.
Star wheel does not turn freely	A	Require repair or replacement.

(1) - Inoperative includes intermittent operation.

SHOE HARDWARE

See BRAKE SHOE HARDWARE.

SHOES

See FRICTION MATERIAL.

SOCKETS

See BULB SOCKETS.

SPEED SENSORS (ELECTRONIC WHEEL AND VEHICLE)

NOTE: Copied Vehicle Speed Sensors from Engine UIGs & added Air Gap incorrect, loose, and wire lead misrouted. For "contaminated" removed coolant & fuel examples from note.

SPEED SENSOR INSPECTION

Condition	Code	Procedure
Air gap incorrect	B	(1) Require adjustment or replacement.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware threads damaged	A	Require repair or replacement of hardware.
Attaching hardware threads stripped (threads missing)	A	Require repair or replacement of hardware.
Connector broken	A	Require repair or replacement.
Connector (Weatherpack type) leaking	A	Require repair or replacement.
Connector melted	A	(2) Require repair or replacement.
Connector missing	C	Require replacement.
Contaminated	A	(3) Require repair or replacement.
Inoperative	B	(4) Require repair or replacement. Further inspection required.
Lead routing incorrect	B	Require rerouting according to vehicle manufacturer's specifications.
Leaking	A	Require repair or replacement.
Loose	A	Require repair or replacement.
Missing	C	Require replacement.
Resistance out of specification	B	Require repair or replacement.
Sensor housing cracked	2	Suggest replacement.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(2) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.
Wire lead conductors exposed	B	Require repair or replacement.
Wire lead corroded	A	Require repair or replacement.
Wire lead misrouted	B	Require re-routing according to vehicle manufacturer's

		specifications.
Wire lead open	A	Require repair or replacement.
Wire lead shorted	A	Require repair or replacement.

(1) - If a sensor is not adjustable, further inspection is required to identify and correct cause.
(2) - Determine cause and correct prior to repair or replacement of part.
(3) - Determine source of contamination, such as metal particles or water. Require repair or replacement.
(4) - Inoperative includes intermittent operation or out of OEM specification. Some components may be serviceable; check for accepted cleaning procedure.

STEEL BRAKE LINES

STEEL BRAKE LINE INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Corroded, affecting structural integrity	A	Require replacement.
Fitting incorrect (for example, compression fitting)	B	Require replacement.
Flare type incorrect	B	Require repair or replacement.
Leaking	A	Require repair or replacement.
Line material incorrect (copper, etc.)	B	Require replacement.
Restricted	A	Require replacement.
Routed incorrectly	B	Require routing correction.
Rust-pitted	1	Suggest replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.

STOPLIGHT SWITCHES

See BRAKE STOPLIGHT SWITCHES.

SWITCHES

NOTE: Copied from Electrical UIGs & added "float saturated" from old fluid level sensor switches.

STEEL BRAKE LINE INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require repair or replacement of hardware.

Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Binding, affecting performance	A	Require repair or replacement.
Binding, not affecting performance	2	Suggest repair or replacement.
Broken	A	Require repair or replacement.
Burned, affecting performance	A	(1) Require repair or replacement.
Burned, not affecting performance	2	(1) Suggest repair or replacement.
Cracked, affecting performance	A	Require repair or replacement.
Cracked, not affecting performance	1	Suggest repair or replacement.
Float saturated	A	Require replacement.
Leaking	A	Require repair or replacement.
Malfunctioning	A	(2) Require repair or replacement.
Melted, affecting performance	A	(1) Require repair or replacement.
Melted, not affecting performance	2	(1) Suggest repair or replacement.
Missing	C	Require replacement.
Out of adjustment	B	Require repair or replacement.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(1) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.
Won't return	A	Require repair or replacement.
Worn	1	Suggest replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - Includes inoperative, intermittent operation, or failure to perform all functions.

TIRES

Consult the vehicle owner's manual or vehicle placard for correct size, speed ratings, and inflation pressure of the original tires.

TIRE INSPECTION

Condition	Code	Procedure
Tire diameter incorrect, affecting ABS or TCS ...	A	.... Require replacement.
Tire pressure incorrect, affecting ABS or TCS ...	A	.. Require repair or replacement.
Tire size incorrect, affecting ABS or TCS ...	A	.... Require replacement.

TOOTHED RINGS (TONE WHEEL)

NOTE: Copied from Drivetrain UIGs.

If the toothed ring requires replacement and cannot be replaced as a separate component, replace the assembly of which the ring is a part.

TOOTHED RING INSPECTION

Condition	Code	Procedure
Alignment incorrect	B	.... Require repair or replacement.
Bent	B	.... Require replacement.
Contaminated, affecting performance	A	.... Require repair. Identify and correct cause.
Cracked	B	.... Require replacement.
Loose	A	.... Require replacement of worn parts.
Missing	C	.... Require replacement.
Number of teeth incorrect	B	.... Require replacement.
Teeth broken	A	.... Require replacement.
Teeth damaged, affecting performance	A	.... Require replacement.

VACUUM BOOSTERS

VACUUM BOOSTER INSPECTION

Condition	Code	Procedure
Applies too much assist (oversensitive)	A	.... Require replacement.
Attaching hardware broken	A	... Require repair or replacement of hardware.
Attaching hardware missing	C	.... Require replacement of hardware.
Attaching hardware not functioning	A	... Require repair or replacement of hardware.
Auxiliary vacuum pump inoperative	A	.... (1) Require repair or replacement.
Check valve grommet deteriorated, affecting performance	A	.. Require replacement of grommet.

Check valve grommet deteriorated, not affecting performance	1	Suggest replacement of grommet.
Check valve inoperative	A	(2) Require repair or replacement.
Check valve leaking	A	Require replacement of check valve.
Check valve missing	C	Require replacement of check valve.
Check valve noisy	2	Suggest replacement.
Connector broken	A	Require repair or replacement.
Connector (Weatherpack type) leaking	A	Require repair or replacement.
Connector melted	A	(3) Require replacement.
Connector missing	C	Require replacement.
Leaking	A	Require replacement.
Terminal burned, affecting performance	A	(3) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.
Vacuum hose filter leaking	A	Require replacement of filter.
Vacuum hose filter restricted	A	Require replacement of filter.
Wire lead burned	A	Require repair or replacement.
Wire lead conductors exposed	B	Require repair or replacement.
Wire lead open	A	Require repair or replacement.
Wire lead shorted	A	Require repair or replacement.

(1) - Inoperative includes intermittent operation or out of OEM specification.
(2) - Inoperative includes intermittent operation.
(3) - Determine cause and correct prior to replacement of part.

VACUUM HOSES

See HOSES.

VALVES

VALVE INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of

		hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Leaking	B	Require repair or replacement.
Linkage bent (rear load valves)	A	Require repair or replacement of linkage.
Linkage broken (rear load valves)	A	Require repair or replacement of linkage.
Linkage disconnected (rear load valves)	C	Require repair or replacement of linkage.
Pressure out of specification	B	Require adjustment. If not possible, require replacement.
Seized	A	Require replacement.
Sticking	A	Require repair or replacement.
Terminal burned, affecting performance	A	(1) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.
Wire lead burned	A	Require repair or replacement.
Wire lead conductors exposed	B	Require repair or replacement.
Wire lead open	A	Require repair or replacement.
Wire lead shorted	A	Require repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.

WHEEL ATTACHING HARDWARE

For conditions noted below, also check condition of wheel stud holes.

CAUTION: Proper lug nut torque is essential. Follow manufacturer's torque specifications and tightening sequence. DO NOT lubricate threads unless specified by the vehicle manufacturer.

WHEEL ATTACHING HARDWARE INSPECTION

Condition	Code	Procedure
Bent	A	Require replacement.
Broken	A	(1) Require replacement.
Loose	B	Require repair or replacement of affected component.

Lug nut flats rounded ...	A	..... Require replacement of nut.
Lug nut installed backward	B	.... Require repair.
Lug nut mating surface dished	A	..... Require replacement of nut.
Lug nut mating type incorrect	B	..... Require replacement of nut.
Lug nut seized	A	...... Require replacement of nut and/or stud.
Stud incorrect	B	.... Require replacement of stud.
Threads damaged	A	... Require repair or replacement of component with damaged threads.
Threads stripped (threads missing)	A	.... Require replacement of component with stripped threads.

(1) - Some manufacturers require replacement of all studs on any wheel if two or more studs or nuts on the same wheel are broken or missing.

WHEEL BEARINGS, RACES AND SEALS

NOTE: Grease seal replacement is required if seal is removed. You are not required to replace these components in axle sets. Determine the need to replace based upon the individual component conditions that follow.

WHEEL BEARINGS, RACES AND SEALS INSPECTION

Condition	Code	Procedure
Axle seal on drive axle leaking	A	. Require replacement of seal and inspection of axle, bearing, housing, and vent tube.
Bearing end-play exceeds specifications	B	.. Require adjustment of bearing, if possible. If proper adjustment cannot be obtained, require replacement of bearing assembly.
Bearing rollers, balls or races are worn, pitted, or feel rough when rotated as an assembly	B	.. Require replacement of bearing assembly.
Seal leaking	A	...... (1) Require replacement of seal and inspection of bearings.
Spindle worn	B	.. Require replacement of spindle and bearings.

(1) - Require inspection of mating and sealing surface and repair or replace as necessary. Check vent. A plugged vent may force fluid past the seal.

WHEEL CYLINDERS

You are not required to replace or rebuild wheel cylinders in axle sets. However, when rebuilding or replacing a wheel cylinder due

to the conditions that follow, you may suggest rebuilding or replacement of the other wheel cylinder (on the same axle) for preventive maintenance, for example, the part is close to the end of its useful life.

Determine the need to rebuild or replace based upon the individual wheel cylinder conditions that follow.

WHEEL CYLINDER INSPECTION

Condition	Code	Procedure
Attaching hardware bent	B	Require replacement of bent parts.
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware corroded, affecting structural integrity	A	Require replacement of corroded parts.
Attaching hardware loose	A	Require repair or replacement.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Bleeder port damaged (if non-repairable)	A	Require replacement.
Bleeder screw broken off in wheel cylinder (if non-repairable)	A	(1) Require replacement.
Bleeder screw plugged	A	(1) Require repair or replacement of bleeder screw.
Bleeder screw seized	A	(2) Require replacement.
Bore corroded (pitted)	B	Require replacement.
Bore grooved	A	Require replacement.
Bore oversized	B	Require replacement.
Dust boot missing	C	Require replacement of dust boot.
Dust boot torn	A	(3) Require replacement of dust boot.
Leaking	A	(4) Require rebuilding or replacement.
Piston corroded, affecting performance	B	Require replacement of piston and rebuilding or replacement of wheel cylinder.
Piston finish worn off	B	Require replacement of piston and rebuilding or replacement of wheel cylinder.
Piston stuck in bore	A	Require replacement of wheel cylinder.
Loose	B	Require repair or replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.

(1) - Only required if the hydraulic system must be opened.
(2) - Seized is defined as bleeder screw that cannot be removed after a practical attempt at removing. Only required if the hydraulic system must be opened.

(3) - Inspect for conditions related to wheel cylinder.
(4) - Leaking is defined as a drop or more. Dampness is normal.

WIRING HARNESSES

NOTE: Copied from Electrical UIGs.

WIRING HARNESS INSPECTION

Condition	Code	Procedure
Application incorrect ...	B	.. Require repair or replacement.
Attaching hardware broken	A	... Require repair or replacement of hardware.
Attaching hardware missing	C	.... Require replacement of hardware.
Attaching hardware not functioning	A	... Require repair or replacement of hardware.
Connector broken	A	.. Require repair or replacement.
Connector (Weatherpack type) leaking	A	.. Require repair or replacement.
Connector melted	A	.... (1) Require repair or replacement.
Connector missing	C	.... Require replacement.
Insulation damaged, conductors exposed	A	.. Require repair or replacement.
Insulation damaged, conductors not exposed .	1	.... Suggest replacement.
Open	A	.. Require repair or replacement.
Protective shield (conduit) melted	2	.... (1) Suggest repair or replacement.
Protective shield (conduit) missing	2	.. Suggest repair or replacement.
Resistance (voltage drop) out of specification ...	A	.. Require repair or replacement.
Routed incorrectly	B	.... Require repair.
Secured incorrectly	B	.... Require repair.
Shorted	A	.. Require repair or replacement.
Terminal broken	A	.. Require repair or replacement.
Terminal burned, affecting performance	A	.... (1) Require repair or replacement.
Terminal burned, not affecting performance ..	2	.. Suggest repair or replacement.
Terminal corroded, affecting performance ..	A	.. Require repair or replacement.
Terminal corroded, not affecting performance ..	2	.. Suggest repair or replacement.
Terminal loose, affecting performance	B	.. Require repair or replacement.
Terminal loose, not affecting performance ..	1	.. Suggest repair or replacement.
Voltage drop out of specification	A	.. Require repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.

1988 BRAKES
Jeep - Brake System

Cherokee, Comanche, Grand Wagoneer, Wagoneer, Wrangler

DESCRIPTION

DISC BRAKES

Floating caliper disc brake assembly uses a single piston caliper which "floats" on 2 bolts. As brake pedal is depressed, hydraulic pressure is passed through a proportioning valve to brake caliper piston.

This force is transmitted to inboard brake pad, forcing it against braking surface of rotor. Pressure then moves outer caliper housing and pad inward on caliper mounting bolts, thus forcing outer pad against outer braking surface of rotor.

DRUM BRAKES

Self-centering type system uses primary and secondary brake shoes with cable operated automatic adjusters. Brake shoe anchor is located at upper end of shoes above wheel cylinder. Single double acting brake cylinder is used.

MASTER CYLINDER - EXCEPT GRAND WAGONEER

The Delco Quick Take-Up master cylinder is used with systems utilizing low drag calipers. Master cylinder includes a quick take-up valve which delivers a large volume of fluid, at low pressure, upon initial brake application.

MASTER CYLINDER - GRAND WAGONEER

Bendix and Delco-Moraine tandem dual piston master cylinders are single casting type with front and rear pistons and a separate reservoir and outlet for each piston. Primary piston is operated by push rod connected to brake pedal. Secondary piston is operated by primary piston.

ADJUSTMENTS

NOTE: For Hub, Bearing and Axle Shaft Removal, Installation and Adjustment information, see appropriate DRIVE AXLES article.

DISC BRAKE PADS

Automatic adjustment is provided by outward relocation of piston as lining wears.

DRUM BRAKE SHOES

1) Rear brake shoes adjust automatically as brakes are applied while vehicle is operated in reverse. Drive vehicle in reverse applying brakes firmly 10-15 times, between each reverse brake application, drive vehicle forward and press brakes firmly.

2) Manual adjustment is required if shoes have been removed

and reinstalled. Brake shoes can be manually adjusted by rotating adjuster screw. Remove access slot cover.

3) Using a small blade screwdriver, push in on adjustment lever to separate from adjustment screw. Turn adjustment screw until brake drum is locked tight. Back screw off until wheel rotates freely. If brake drum is to be removed, back off adjustment screw several notches for adequate clearance.

HEIGHT SENSING PROPORTIONING VALVE - COMANCHE

NOTE: Anytime adjustment is required the lever bushing must be replaced.

Adjustment must be made on a drive-on lift or a flat level surface with vehicle at curb weight. Remove height sensing proportioning valve shaft nut and washer. Disconnect valve lever and remove spring. Remove and discard bushing.

Rotate valve shaft to permit installation and proper alignment of valve adjusting gauge (J-35853-2).

NOTE: The gauge (J-35853-2) must be properly seated on the "D" shape of the shaft and the lower mounting bolt of the valve. See Fig. 2. Also, all linkage components, excluding the spring, must be connected to the axle housing before installation of bushing.

Place lever bushing in lever. Using bushing installation tool (J-35853-1) press bushing along with lever onto valve shaft. Remove lever and adjusting to (J-35853-2) then install the spring. Install lever, washer and retaining nut. Tighten retaining nut to 100 Inch-lbs. (11 N.m). Connect spring to lever arm.

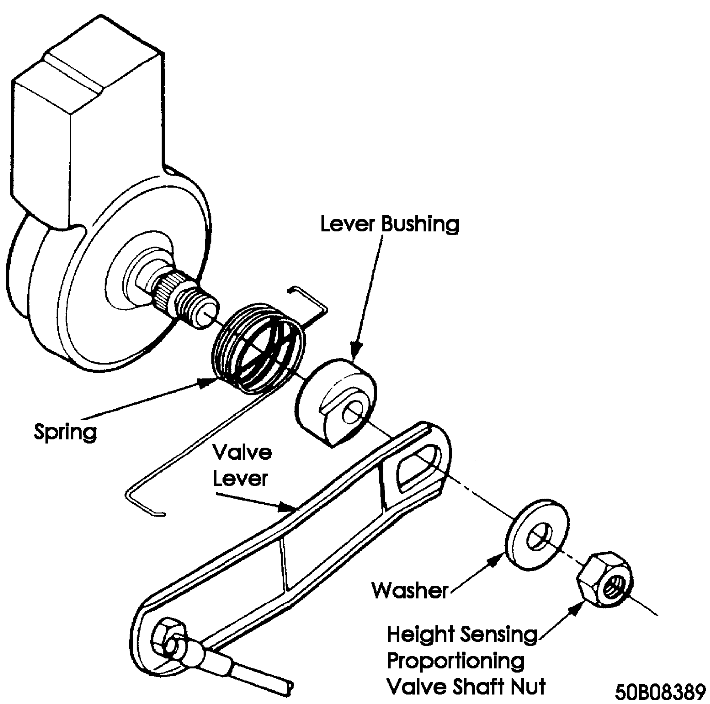


Fig. 1: Exploded View of Height Sensing Proportioning Valve

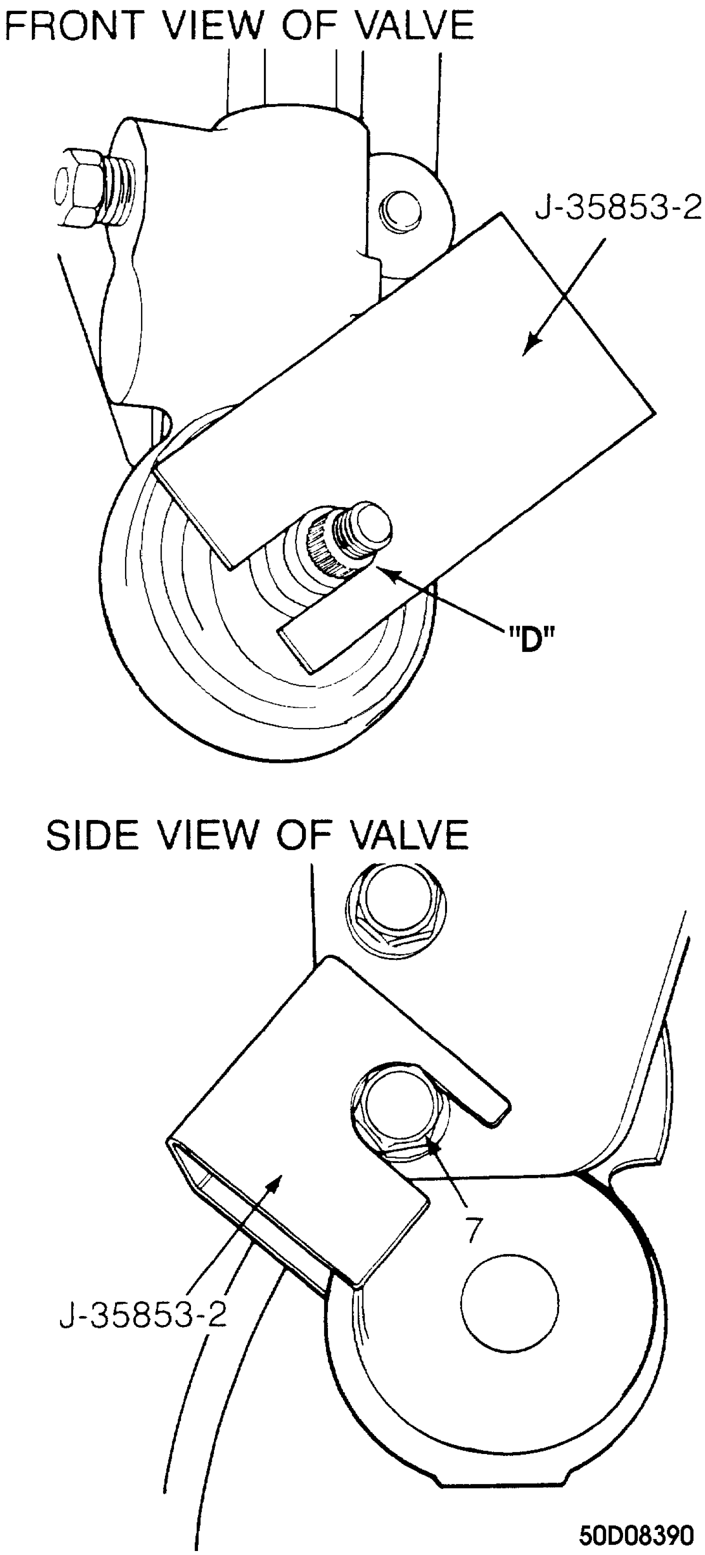


Fig. 2: Front and Side View of Valve Shaft

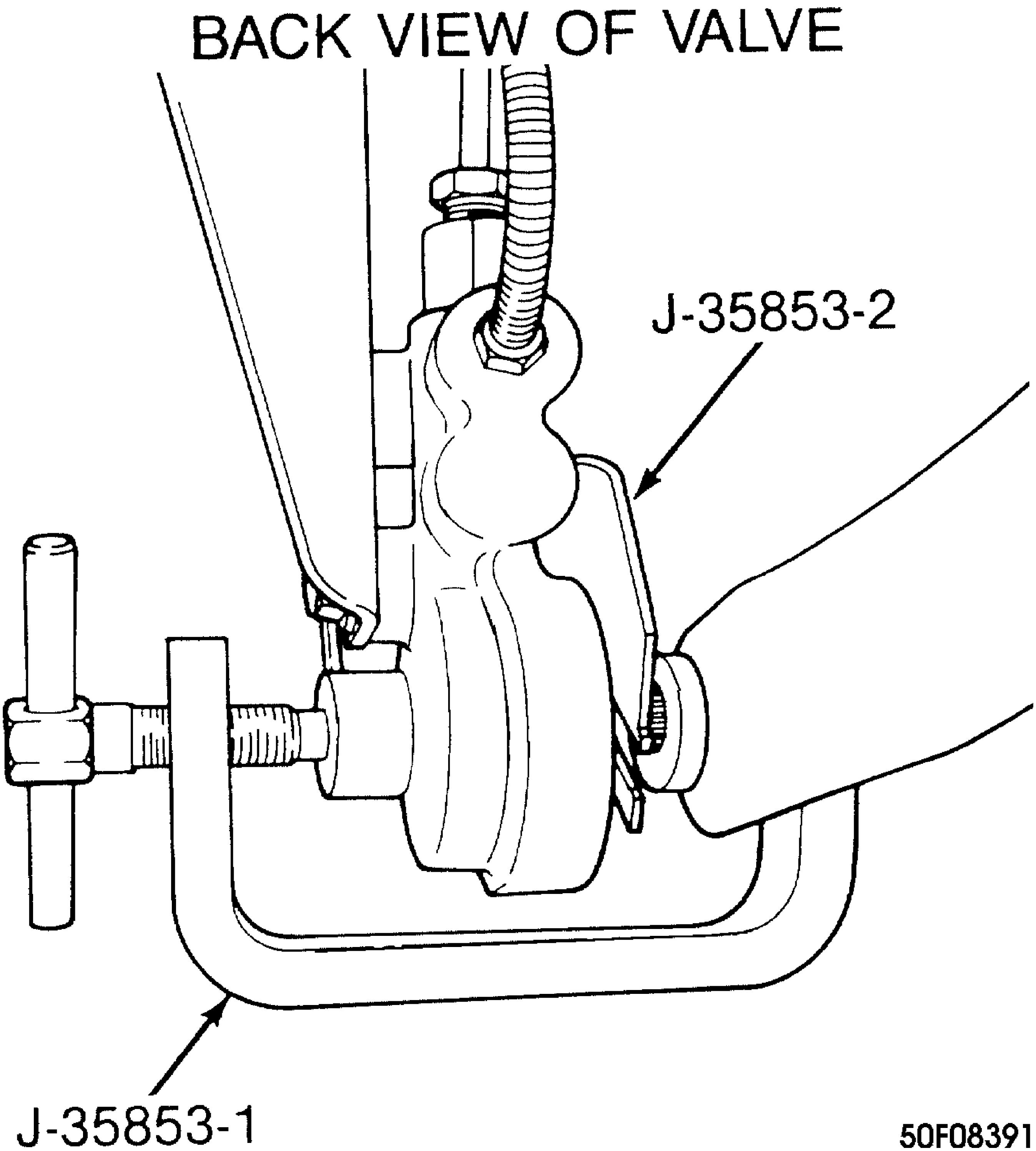


Fig. 3: Back View of Valve Shaft

PARKING BRAKE - EXCEPT GRAND WAGONEER

1) Adjust rear brakes. Check cable for binds, kinks or frayed condition. Replace cable (if necessary). Apply and release parking brake 5 times.

2) On all models except Wrangler, place parking brake lever in fifth notch. Raise vehicle. Using Adjustment Gauge (J-34651), apply a torque of 50-55 INCH lbs. (5-6 N.m). See Fig. 4.

3) Adjust nut on parking brake cable equalizer until pointer is in Blue section of gauge. Apply and release parking brake cable 5 times. Check adjustment and readjust cable (if necessary).

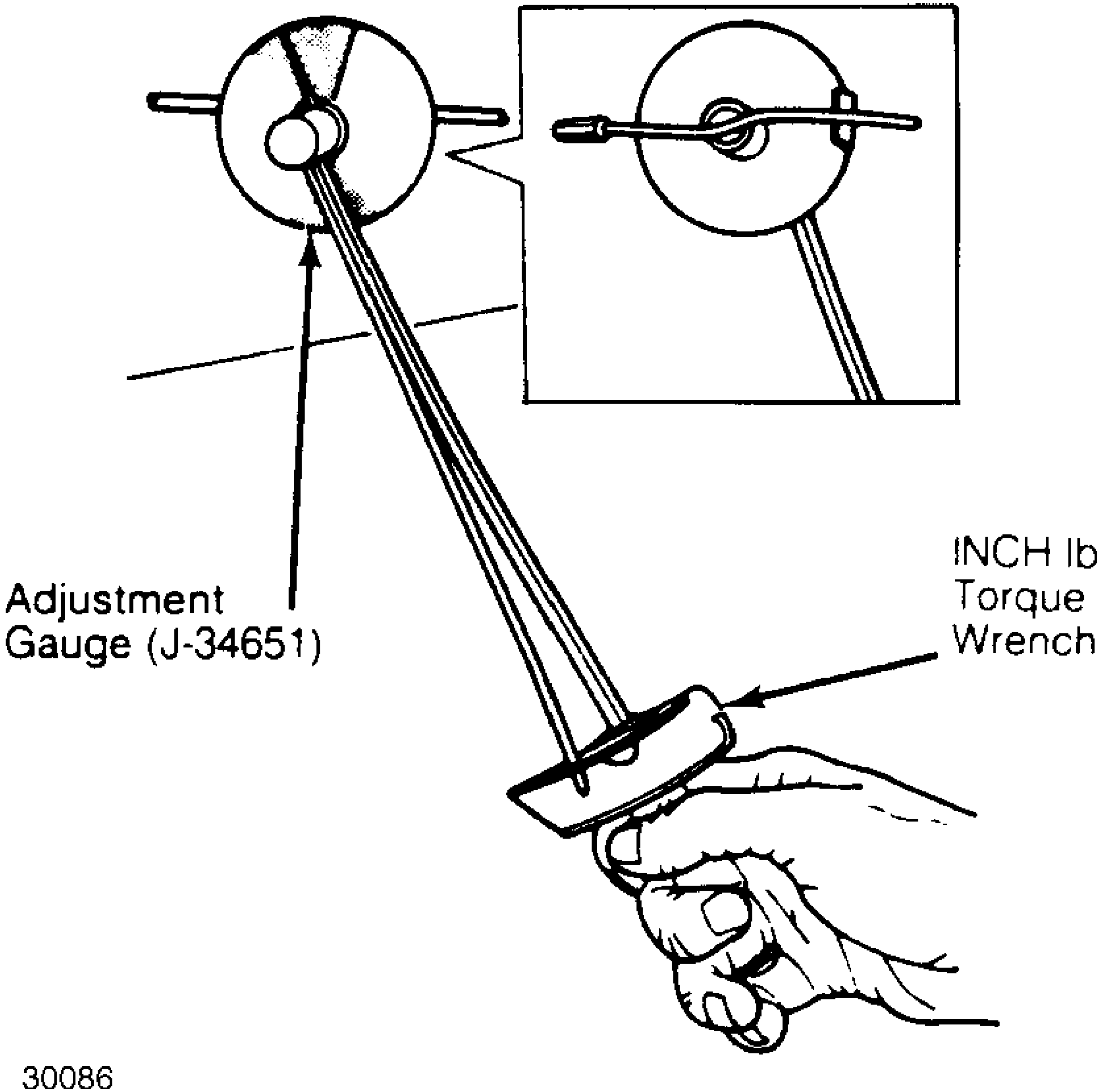


Fig. 4: Parking Brake Adjustment (Except Grand Wagoneer)
Courtesy of American Motors/Jeep Corp.

PARKING BRAKE - GRAND WAGONEER

1) Adjust rear brakes. Check cable for binds, kinks or frayed condition. Replace cable (if necessary). Release parking brake. Loosen lock nuts at parking brake cable equalizer under vehicle.

2) Tighten cables until wheels drag slightly when rotated by hand. Loosen equalizer until wheels rotate freely and no drag is felt. Tighten lock nuts and check operation of parking brake.

ROTOR SERVICING

RUNOUT

1) Measure rotor lateral runout by mounting a dial indicator on support stand or steering spindle. Position indicator stylus so it contacts center of rotor braking surface.

2) Zero indicator and turn rotor one revolution. Note indicator reading. Runout must not exceed specification. See DISC BRAKE ROTOR SPECIFICATIONS table. Refinish or replace rotor (if necessary).

NOTE: Thickness of machined rotor must not be below minimum thickness specification.

PARALLELISM

Measure rotor parallelism with a micrometer. Measure thickness at 4 or more equally spaced points around rotor at approximately 1" from edge of rotor. Variation must not exceed specification. See DISC BRAKE ROTOR SPECIFICATIONS table. Refinish or replace rotor (if necessary).

BRAKE SYSTEM BLEEDING

Hydraulic system bleeding is necessary any time air has been introduced into system. Bleed brakes at all 4 wheels if master cylinder lines have been disconnected or master cylinder has run dry. Bleed brakes with vacuum bleeding equipment, pressure bleeding equipment or by manually pumping brake pedal while using bleeder tubes. Always bleed brake lines in sequence. See BLEEDING SEQUENCE table.

MASTER CYLINDER BLEEDING

Bench Bleeding

1) Master cylinder must be bled before installation to prevent excessive amounts of air from entering the brake system, creating poor brake operation.

2) Place master cylinder in soft-jawed vise. DO NOT tighten vise enough to damage master cylinder. Install bleeder tubes in both outlets of master cylinder. See Fig. 5.

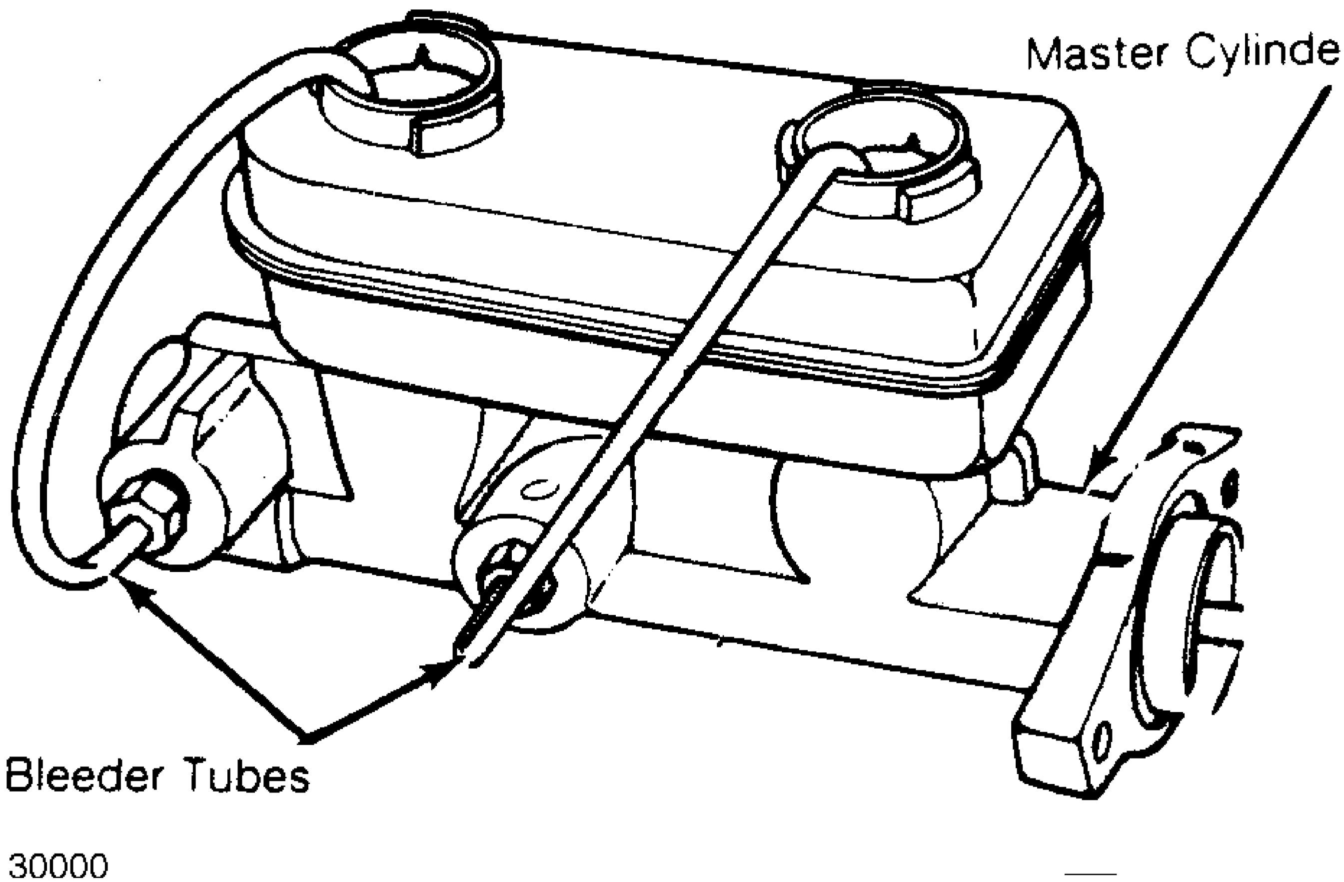


Fig. 5: Bleeding Master Cylinder
Courtesy of American Motors/Jeep Corp.

3) Fill master cylinder with clean brake fluid that meets DOT 3 specifications. Ensure that the end of bleeder tubes are submerged in the brake fluid.

4) Using proper sized rod, apply and release master cylinder until no air bubbles exist in brake fluid flow. Once all air bubbles are gone from master cylinder secure cap and install.

5) Bleeder tubes should be left installed on master cylinder until master cylinder in installed. Master cylinder must be bled at brake lines and wheels after installation.

Bleeding On Vehicle

1) Install master cylinder on vehicle after bench bleeding. Remove bleeder lines and install brake lines. DO NOT fully tighten brake lines at this time.

2) Slowly force brake pedal to the floor and hold in this position. Tighten brake lines and release brake pedal. Repeat procedure until no air bubbles exist at brake lines. Remaining wheel cylinder or calipers may be require bleeding.

HYDRAULIC CONTROL VALVES

Hold Off Valve

1) Prior to the pressure tank bleeding procedure, the hold off valve incorporated in the combination valve must be correctly positioned. This allows brake fluid to flow through the combination valve to the entire brake system.

2) The valve stem of the hold off valve may be retained using

tools available from Chrysler Motors (C-4121) or General Motors (J-23709) during bleeding procedure. See Figs. 6 and 7. Remove valve retainer once brake bleeding procedure is complete.

CAUTION: DO NOT use rigid clamp to position valve stem. Damage to the valve assembly may result causing brake failure.

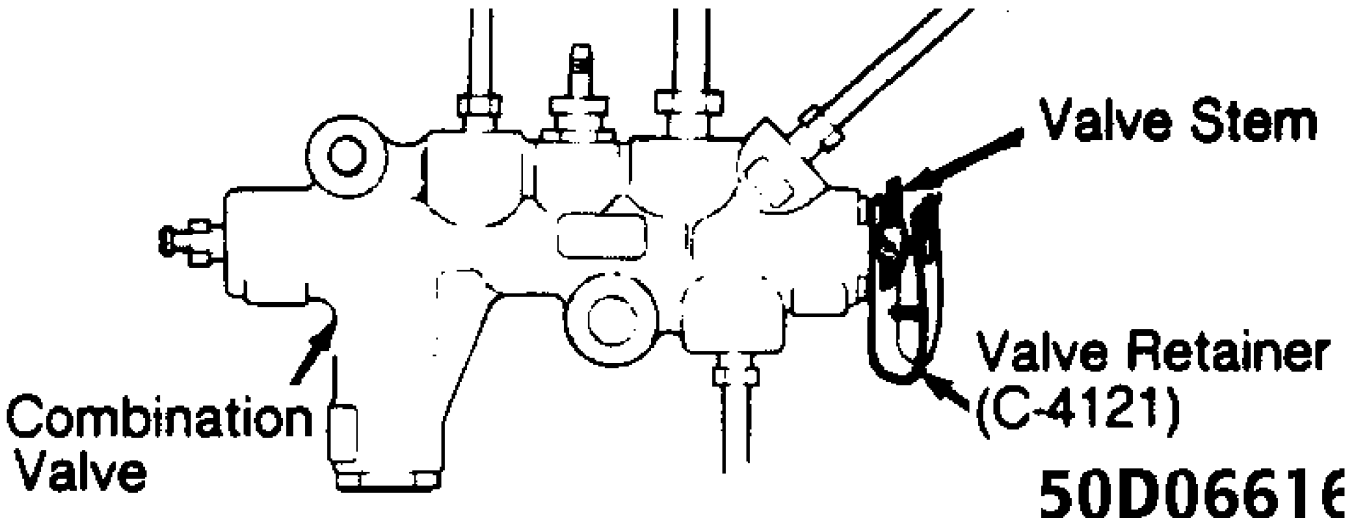


Fig. 6: Positioning Hold Off Valve
Courtesy of American Motors/Jeep Corp.

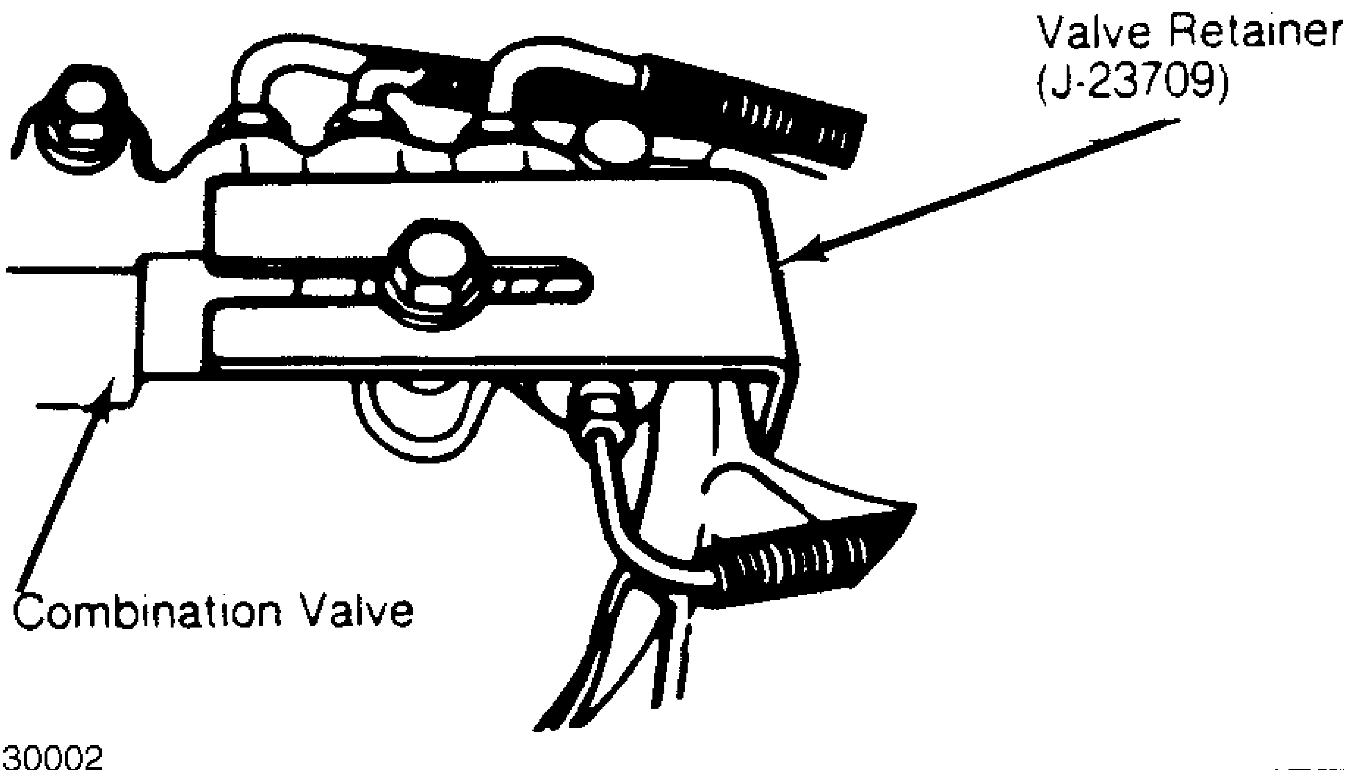


Fig. 7: Positioning Hold Off Valve
Courtesy of American Motors/Jeep Corp.

VACUUM BLEEDING

Fill master cylinder. Install vacuum bleed equipment to first bleeder valve to be serviced. Open bleeder valve 3/4-1 turn. Depress vacuum pump and pull fluid into reservoir jar. Bleed each bleeder valve in sequence. See BLEEDING SEQUENCE table.

PRESSURE BLEEDING

1) Clean master cylinder cap and surrounding area. Remove cap. With pressure tank at least 1/2 full, connect to master cylinder with adapters. Attach bleeder hose to first bleeder valve to be serviced. See BLEEDING SEQUENCE table.
2) Place other end of hose in clean glass jar partially filled with clean brake fluid so end of hose is submerged in fluid. The hold off valve must be positioned properly before pressure bleeding (if equipped). See HYDRAULIC CONTROL VALVES under BRAKE SYSTEM BLEEDING in this article.
3) Open release valve on pressure bleeder. Follow equipment manufacturer's pressure instructions or see PRESSURE BLEEDER SETTINGS table. Open bleeder screw 3/4-1 turn and note fluid flow.
4) Close bleeder screw when fluid flowing is free of bubbles. Repeat procedure on remaining wheels in proper sequence. Check brake pedal operation after bleeding has been completed.
5) Remove pressure bleeding equipment and valve retainer from hold off valve. Ensure that master cylinder is full of fluid.

PRESSURE BLEEDER SETTINGS TABLE

Application	psi (kg/cm^2)
All Models	15-20 (1.1-1.4)

MANUAL BLEEDING

NOTE: When bleeding disc brakes, air may tend to cling to caliper walls. Lightly tap caliper, while bleeding, to aid in removal of air.

1) Fill master cylinder. Install bleeder hose to first bleeder valve to be serviced. See BLEEDING SEQUENCE table. Submerge other end of hose in clean glass jar partially filled with clean brake fluid. See Fig. 8.
2) Open bleeder valve 3/4-1 turn. Depress brake pedal slowly through full travel. Close bleeder valve and release pedal. Repeat procedure until flow of fluid shows no signs of air bubbles.

NOTE: When bleeding brake system manually, ensure bleeder valve is closed when brake pedal is released.

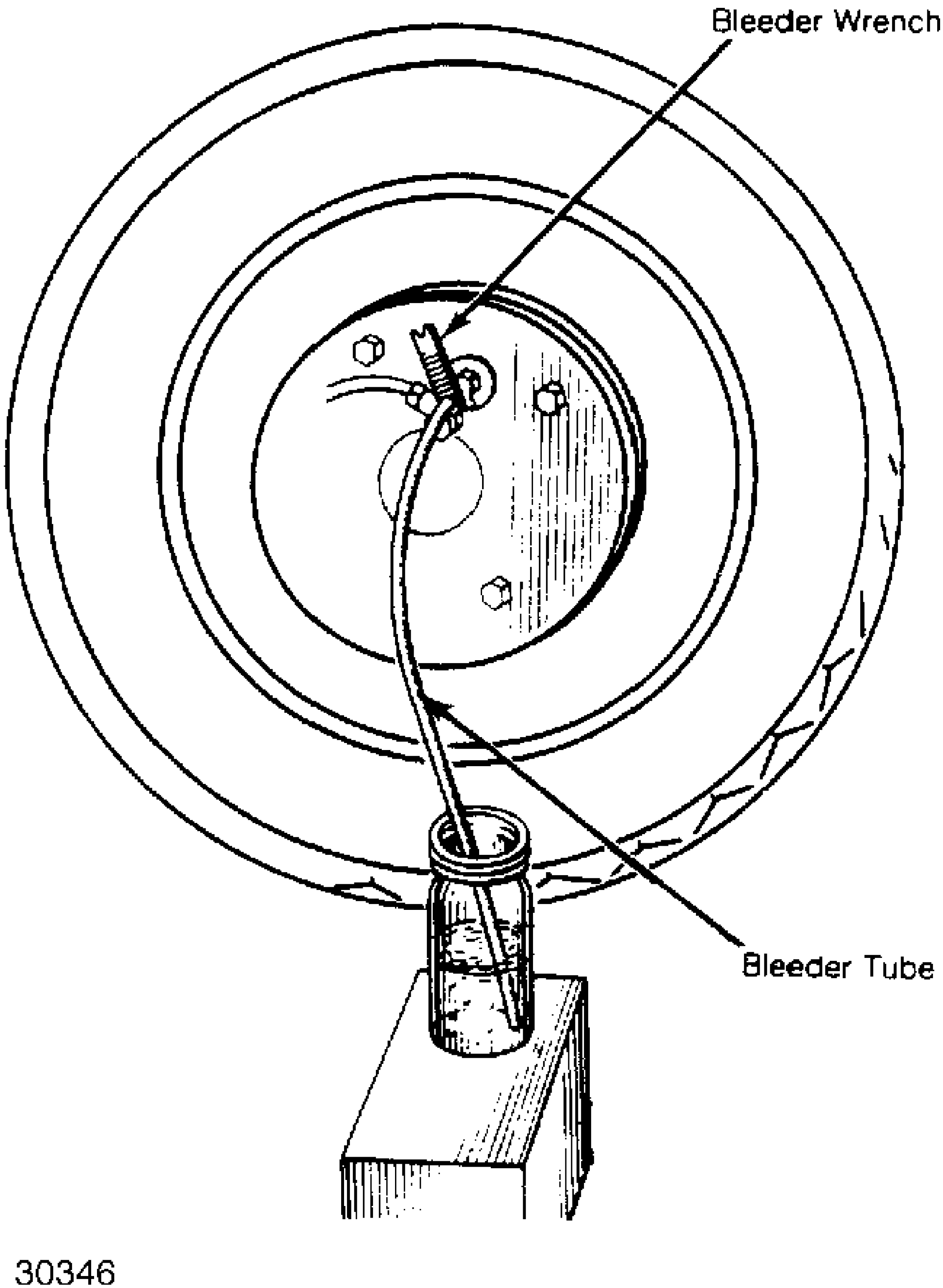


Fig. 8: Wheel Cylinder Bleeding Procedure
Courtesy of American Motors/Jeep Corp.

BLEEDING SEQUENCE

Before bleeding system, exhaust all vacuum from power unit by depressing brake pedal several times. Bleed master cylinder (if equipped) with bleeder screws. Bleed slave cylinder on vehicles equipped with remote mount power assist units. Bleed wheel cylinders and calipers in sequence. See BLEEDING SEQUENCE table.

BLEEDING SEQUENCE TABLE

Application	Sequence
All Models	RR, LR, RF, LF

REMOVAL & INSTALLATION

DISC BRAKE CALIPER

Removal & Installation

Caliper removal and installation procedures are same as for disc pad replacement. To remove caliper from vehicle, disconnect brake line at caliper and cap hole to prevent contamination.

DISC BRAKE PADS

Removal

1) Drain 2/3 of brake fluid from master cylinder reservoir. Raise vehicle and support with safety stands. Remove front wheel assembly.

2) Place "C" clamp on caliper. Solid end of clamp should contact back of caliper. Screw end should contact metal part of outboard shoes.

3) Tighten "C" clamp until caliper forces piston to bottom of bore. Remove both Allen head mounting bolts and lift caliper off rotor. Support caliper out of the way.

4) On Grand Wagoneer, remove both brake pads from caliper. Note spring position and support spring from inboard shoe. Remove sleeves and bushings from caliper.

5) On all other models, hold anti-rattle clip against caliper adapter and remove outer brake pad. Remove inner brake pad and anti-rattle clip from caliper adapter.

Installation

1) To install, reverse removal procedure. On Grand Wagoneer, lubricate new bushings, sleeves, bushing grooves, and small ends of mounting bolts with silicone lubricant. Install rubber bushings in caliper mounting ears.

2) On all other models, clean caliper mating surfaces on adapter with a wire brush. Apply double sided adhesive tape to back side of inner pad. Clean caliper piston surface. Lubricate caliper mating surfaces on caliper adapter.

3) On all models, lubricate caliper mounting bolts using brake corrosion lubricant and tighten mounting bolts. Add brake fluid to reservoir. Apply brakes until brake pedal is firm. Check brake fluid level.

DISC BRAKE ROTOR - WRANGLER

Removal

Raise and support vehicle. Remove front wheel and caliper. Suspend caliper from frame or suspension. Remove rotor from hub.

Installation

Clean hub and rotor mating surfaces. To install, reverse removal procedure.

NOTE: DO NOT disconnect brake hose from caliper unless caliper is to be disassembled.

DISC BRAKE ROTOR - CHEROKEE, COMANCHE & WAGONEER

Removal

1) Raise and support vehicle. Remove front wheel and caliper. Suspend caliper from frame or suspension. Remove cap, cotter pin, nut retainer, adjusting nut and thrust washer from spindle.

2) Remove outer bearing from hub. Remove hub and rotor from spindle. Remove hub and rotor seal. Remove inner bearing from hub.

Installation

1) Apply small amount of "EP" type waterproof wheel bearing grease in hub cavity. Lubricate inner and outer bearings. Install inner bearing and seal in rotor. Clean rotor surface (if necessary).

2) Install hub and rotor on spindle. Install outer bearing, thrust washer and spindle nut. Tighten spindle nut to 17-25 ft. lbs. (23-34 N.m) while rotating rotor to seat bearings. Loosen spindle nut 1/2 a turn and retighten an additional 19 INCH lbs (2 N.m). Reverse removal procedure to complete installation.

DISC BRAKE ROTOR - GRAND WAGONEER

Removal

1) Raise vehicle and support with safety stands. Remove wheel and caliper. On models without front hubs, remove rotor hub cap, drive gear snap ring, drive gear, pressure spring and spring cup.

2) On models with front hubs, remove screws attaching hub body to hub clutch and remove hub body from clutch. Remove large and small retaining rings. Remove hub clutch from axle shaft.

3) On all models, remove wheel bearing outer and inner lock nuts and retaining ring using Socket (J-6893-D). Remove rotor. Remove wheel bearings from rotor.

Installation

1) Lubricate bearings with "EP" type waterproof wheel bearing grease. Install bearings and seal in rotor. Install rotor and inner lock nut. Inner lock nut has a locating peg on one side. When installed, peg must face away from bearing.

2) Install wheel, but do not tighten lug nuts completely. Tighten inner lock nut to 50 ft. lbs. (68 N.m) while rotating wheel. Back of inner lock nut 1/6 turn (45-65 degrees).

3) Install retaining washer. Ensure that inner lock nut locating peg is engaged with retaining washer. Install outer lock nut and tighten to 50 ft. lbs. (68 N.m).

4) On models without front hubs, install pressure spring cup, pressure spring, drive gear and snap ring. Coat rim of chrome hub cover with Permatex No. 3 and install cap in rotor hub.

NOTE: Recessed side of spring cup faces outer bearing and flat side faces pressure spring.

5) On models with front hubs, install hub clutch on axle. Install large and small hub retaining rings. Install hub body on clutch and tighten to 30 INCH lbs. (3 N.m). Reverse removal procedure to complete installation.

DRUM BRAKE SHOES - EXCEPT GRAND WAGONEER

Removal

1) Raise vehicle and support with safety stands. Remove wheel assembly and drum. Remove "U" clip and washer from parking brake lever pivot pin. Place Wheel Cylinder Clamp (J-8002) over wheel cylinder.

2) Remove primary and secondary return springs, spring retainers, hold-down springs and retaining pins. Remove adjuster lever, adjuster screw and spring from brake shoes. Remove brake shoes. See Fig. 9.

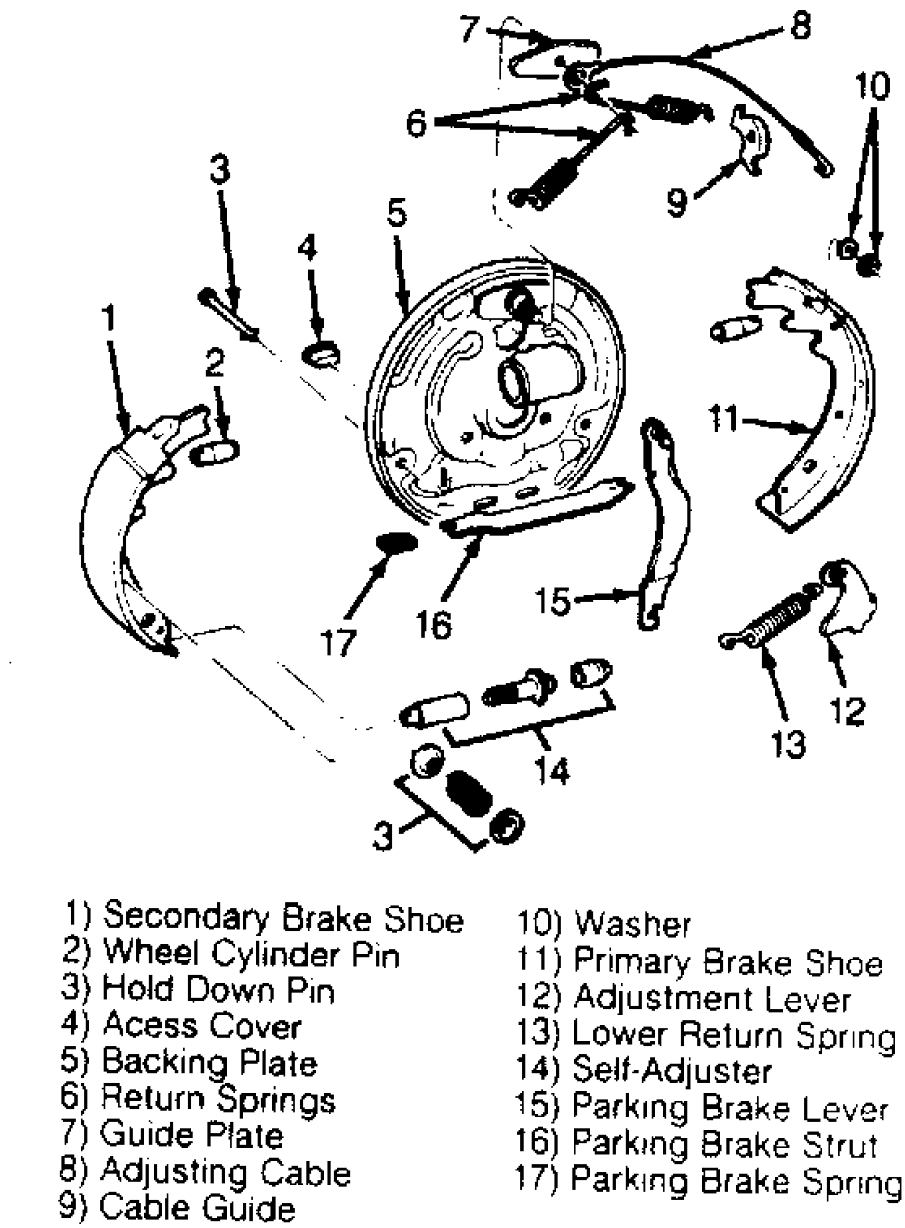


Fig. 9: Exploded View of Drum Brake (W/Cable Operated Adjuster)
Courtesy of American Motors/Jeep Corp.

Installation

1) Lubricate support plate ledges, anchor pin, adjuster cable

guide, adjuster screw assembly, parking brake lever and lever pivot pin with molybdenum disulphide grease.

2) Connect parking brake lever to secondary brake shoe with washer and "U" clip. Crimp ends of clip to secure clip on pivot. Remove wheel cylinder clamp. Position brake shoes on brake support plate and install hold-down springs.

3) Install parking brake lever strut and spring. Install adjuster cable guide plate and adjuster cable on anchor pin. Install primary return spring. Install guide to secondary brake shoe. Install secondary return spring.

4) Install adjuster screw, spring and lever. Connect lever to cable. Using Brake Gauge (J-21177-01), preset brake shoe adjustment. Install brake drums. Adjust brake shoes with drum in place.

5) Install wheels and lower vehicle. To adjust and balance brake system, apply and release brakes 10-15 times while driving forward and backward. Road test vehicle.

DRUM BRAKE SHOES - GRAND WAGONEER

Removal

1) Raise vehicle and support with safety stands. Remove wheels. On models with full-floating rear axle, remove 2 screws that retain drum on hub.

2) On all models, remove primary shoe return spring, automatic adjuster actuator spring and secondary shoe return spring. Remove hold-down springs. Remove brake shoe assemblies. See Fig. 10.

3) Disengage parking brake cable from parking brake lever. Remove parking brake strut and brake shoe assembly as a unit. Place wheel cylinder clamps over cylinders in order to retain pistons.

4) Inspect automatic adjuster lever and pivot, actuating lever, parking brake lever, automatic adjuster and springs. Replace weak springs, bent levers and parts that are worn or broken.

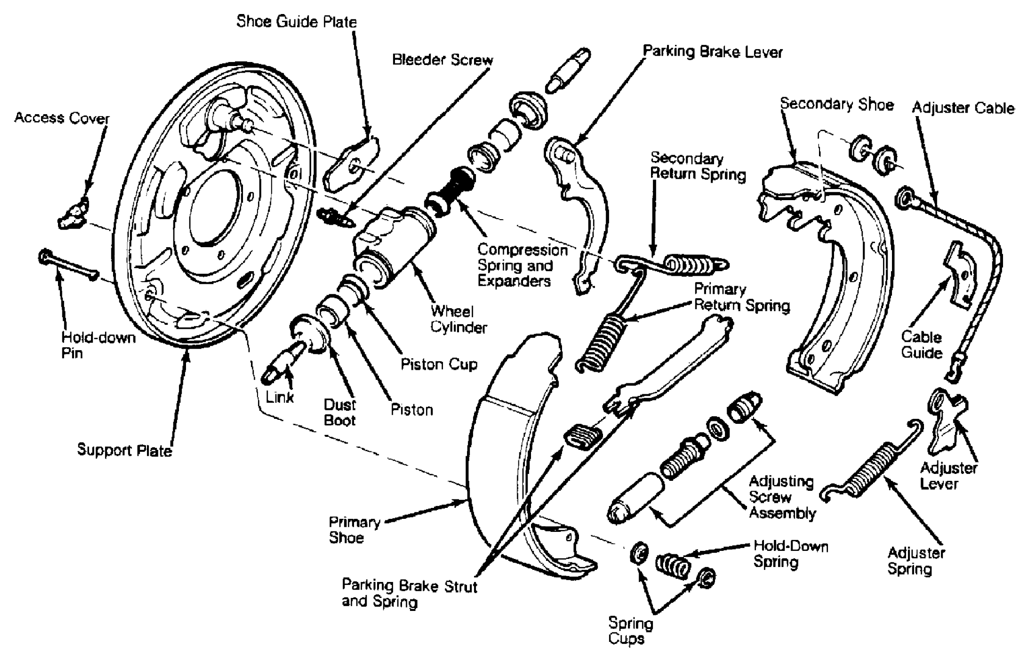


Fig. 10: Exploded View of Drum Brake Assembly (Grand Wagoneer)
Courtesy of American Motors/Jeep Corp.

Installation

1) Clean support plate. Apply a thin film of molybdenum

disulphide grease or chassis lubricant on support plate ledges, anchor pin, adjuster screw threads and pivot.

2) Apply grease to adjuster lever-to-secondary brake shoe contact surface, parking brake lever pivot and portion of lever that contacts secondary brake shoe.

3) Attach parking brake cable to parking brake lever on secondary shoe. Pinch "U" clip to retain lever on shoe. Install secondary brake shoe, automatic adjuster lever and lever pivot as an assembly.

4) Install brake shoe hold-down spring. Install return spring on actuating lever tang. Large end of tapered spring should rest on brake shoe.

5) Install primary shoe and hold-down spring. Install guide plate on anchor pin. Install parking brake strut and spring on brake shoes.

6) Install adjusting screw and spring. Short end of hooked spring attaches to primary brake shoe. Long hooked end attaches to secondary brake shoe.

7) Install secondary shoe return spring, adjuster spring and primary return spring. Install brake drums. Adjust brakes. Bleed brake system.

8) Install wheels and lower vehicle. Apply and release brakes 10-15 times while driving forward and backward to adjust and balance brake system. Road test vehicle.

MASTER CYLINDER - EXCEPT GRAND WAGONEER

Removal

1) With engine off, depress brake pedal several times to release vacuum in power unit. Clean dirt and grease from brake line connections.

2) Disconnect and plug brake lines at master cylinder. Remove retaining nuts and master cylinder.

Installation

To install, reverse removal procedure. Bleed brake system. See BRAKE SYSTEM BLEEDING in this article.

MASTER CYLINDER - GRAND WAGONEER

Removal

Disconnect brake lines at master cylinder and plug. On vehicles without power assist units, disconnect brake pedal push rod at brake pedal. Remove master cylinder retaining nuts at firewall. Remove master cylinder.

Installation

1) Master cylinder should be bench bled before installation. See BRAKE SYSTEM BLEEDING in this article. Position master cylinder on vehicle. Loosely install retaining nuts. Loosely install brake lines to cylinder. Tighten retaining nuts. Tighten brake lines.

2) Connect brake pedal push rod (if removed). Fill reservoir with brake fluid and bleed brake system. See BRAKE SYSTEM BLEEDING in this article.

REAR AXLE BEARING & SEAL

Removal

1) Raise vehicle and support with safety stands. Remove wheel assembly and brake drum. Remove support plate retaining nuts through hole provided in axle flange. Use a slide hammer to remove axle shaft.

2) If wheel bearing cup remains in housing, use Slide Hammer (J-2619-01) and Bearing Remover (J-26941) to remove bearing cups.

Remove axle shaft oil seal from axle housing tube.

3) Place axle shaft in a vise. Drill a 1/4" (6.35 mm) hole 3/4 of the way through bearing retaining ring. Chisel off bearing retaining ring. Do not use a torch. Press bearing off axle. Remove seal and retainer plate.

Installation

Lubricate bearing and seal lip. Install retainer plate and seal over axle. Press axle shaft bearing and retaining ring on shaft simultaneously. Ensure bearing and ring are seated against axle shaft shoulder. To complete installation, reverse removal procedure to complete installation.

WHEEL CYLINDER

Removal

Remove wheel assemblies, brake drums and brake shoes. Disconnect brake line at wheel cylinder. Do not bend brake line away from cylinder. Remove cylinder-to-support plate bolts. Remove cylinder.

Installation

To install, reverse removal procedure. Start brake line fitting into cylinder before installing cylinder to support plate.

OVERHAUL

DISC BRAKE CALIPER

Disassembly

1) Clean caliper exterior with brake cleaning solvent. Drain residual fluid from caliper and place caliper on a clean working surface.

2) Remove piston from caliper by applying compressed air to inlet port. Use just enough pressure to ease piston out of bore. Protect piston from damage with folded shop towels. Do not try to catch piston by hand.

3) Pry dust boot out of bore with screwdriver. Do not scratch bore. Using a small plastic or wooden stick, pry piston seal from bore. See Fig. 11. Remove bleeder screw, sleeves, and bushings.

Cleaning & Inspection

Clean all parts with brake cleaning solvent. Blow dry parts. Check for damaged or worn parts. Stains on piston bore can be polished with crocus cloth. Do not use emery cloth or any other abrasive.

Reassembly

1) Lubricate bore and new seal with brake fluid. Install seal in groove using fingers. Lubricate piston with brake fluid. Slide metal retainer portion of dust boot over open end of piston. Pull boot rearward until boot lip seats in piston groove.

2) Push retainer portion of dust boot forward until boot is flush with rim at open end of piston and boot fold snaps into place. Insert piston in bore being careful not to unseat piston seal.

3) Push piston to bottom of bore using hammer handle. Position dust boot retainer in counterbore at top of piston bore. Seat dust boot retainer with Dust Boot Installer (J-22904 or J-33028). Reverse removal procedure to complete installation.

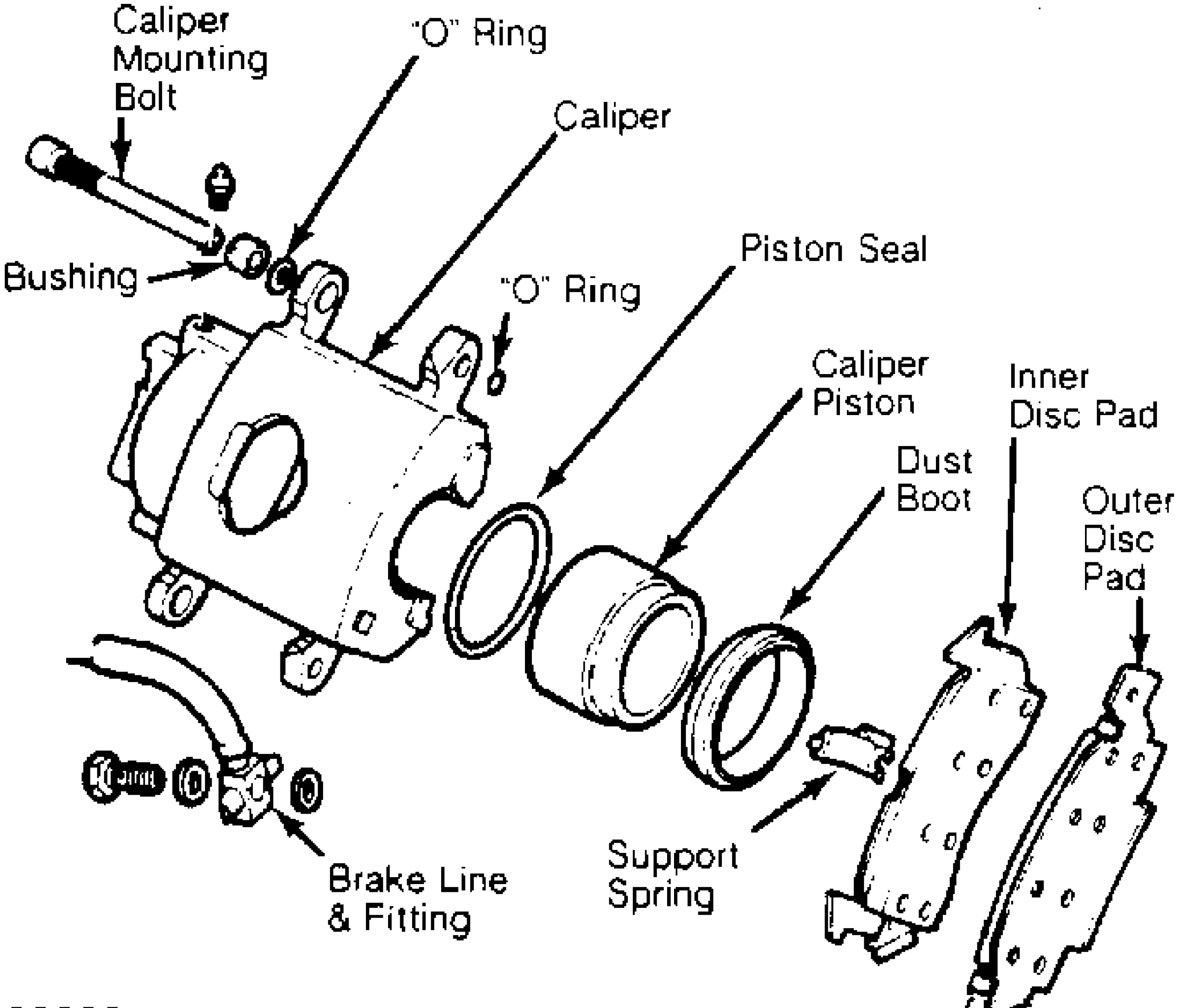


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Fig. 11: Caliper Assembly (Grand Wagoneer)
Courtesy of American Motors/Jeep Corp.

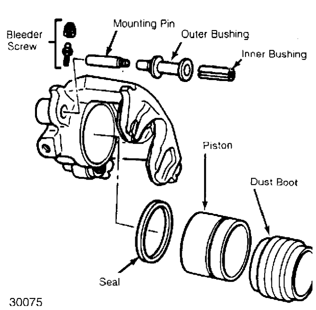

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Fig. 12: Caliper Assembly (Except Grand Wagoneer)
Courtesy of American Motors/Jeep Corp.

MASTER CYLINDER - EXCEPT GRAND WAGONEER

NOTE: Do not hone master cylinder. Bore has a highly polished "Bearingized" surface. Honing will cause premature failure of rubber parts.

Disassembly

1) Remove reservoir cover and diaphragm. Drain remaining brake fluid. Push in on primary piston and remove snap ring.

2) Carefully apply compressed air at forward brake line hole while plugging rear hole. Use caution as piston will be forced out open end of master cylinder with considerable force.

3) Remove spring retainer and seals from secondary piston. Discard seals. Clamp mounting ear of master cylinder in vise and carefully pry off reservoir.

4) Do not attempt to remove take-up valve from master cylinder as it is not a serviceable component. Remove reservoir grommets and discard.

Inspection

Inspect cylinder bore for scoring or corrosion. If signs of corrosion are evident, replace master cylinder. Use no abrasives on cylinder bore. Inspect reservoir cover and diaphragm for cuts, cracks or deformation. Replace damaged or defective parts as necessary.

Reassembly

1) Lubricate new reservoir grommets with clean brake fluid and press into master cylinder. Ensure grommets are properly seated. Lay reservoir on flat, hard surface. Rock master cylinder body onto reservoir until completely seated.

2) Lubricate new piston seals with clean brake fluid and install on secondary piston, with lip of seals toward ends of piston. Install spring retainer.

3) Install secondary piston spring and secondary piston assembly in master cylinder. Lubricate primary piston seals with clean brake fluid.

4) Install primary piston in master cylinder. Press in piston and install snap ring. Fit diaphragm in reservoir cover and install cover.

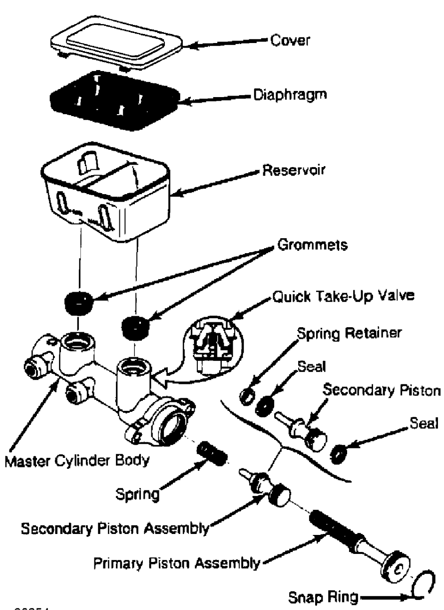

Fig. 13: Exploded View of Quick Take-Up Master Cylinder
Courtesy of General Motors Corp.

MASTER CYLINDER - GRAND WAGONEER

NOTE: Do not hone master cylinder bore. Bore has a highly polished "bearingized" surface. Honing will cause premature failure of rubber parts.

Disassembly

1) Clean outside of cylinder thoroughly and remove cover. Drain fluid. Pump piston to remove any remaining fluid. On Delco/Moraine models with composite fluid reservoir, install metal flange in vise and pry reservoir off with a pry bar. Bendix composite reservoir is held on by 4 bolts on bottom of reservoir. On manual brake models, remove boot from cylinder to uncover push rod retainer.

2) Pry up retainer tab to release retainer. Remove snap ring from groove in cylinder bore. Remove both piston assemblies. Remove remaining internal parts from bore. Note direction of piston seals. Remove and discard all rubber parts from piston assemblies.

3) Tube seats can be removed if damaged. Enlarge holes in tube seats using a 13/64" drill. Place a large flat washer over outlet and thread a 1/4" x 20 x 3/4" screw into seat. Tighten screw until seat is loose. See Fig. 14. Remove seat, screw and washer.

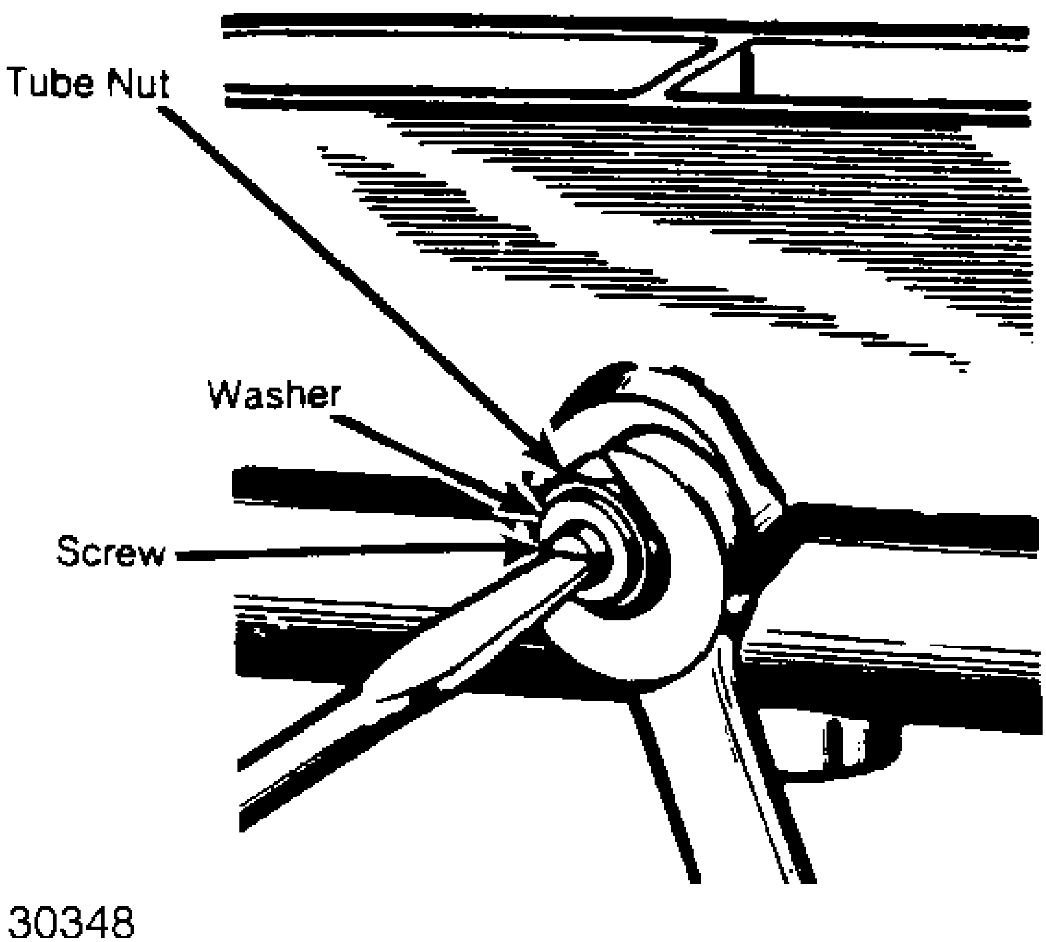

Fig. 14: Removing Tube Seat from Master Cylinder
Courtesy of American Motors/Jeep Corp.

Inspection

Inspect cylinder bore for scoring or corrosion. Staining

which has not pitted or roughened surface of cylinder can be removed with crocus cloth. If cylinder bore is scored, pitted or corroded, replace master cylinder.

Reassembly

1) Install replacement tube seats by threading a spare brake line tube nut into hole. Turn nut in until tube seat bottoms. Do not cock tube seat in hole. Remove nut and check for burrs which may have been loosened by nut. Install secondary seals on secondary piston, with cup lips facing away from each other.

2) Install primary seal, spring retainer and return spring on secondary piston. Install seal so lip faces interior of master cylinder when installed. Lubricate cylinder bore with clean brake fluid and install secondary piston assembly. Lubricate primary piston seals and install primary piston assembly in bore. Hold primary piston downward in bore and install snap ring.

3) Install composite reservoir (if equipped). On models with push-on composite fluid reservoir, invert reservoir, install grommets and press on body using a rocking motion. Install master cylinder cover and new diaphragm.

4) On vehicles with manual brakes, assemble brake pedal push rod through retainer (if equipped). Push retainer over end of master cylinder and install rubber boot.

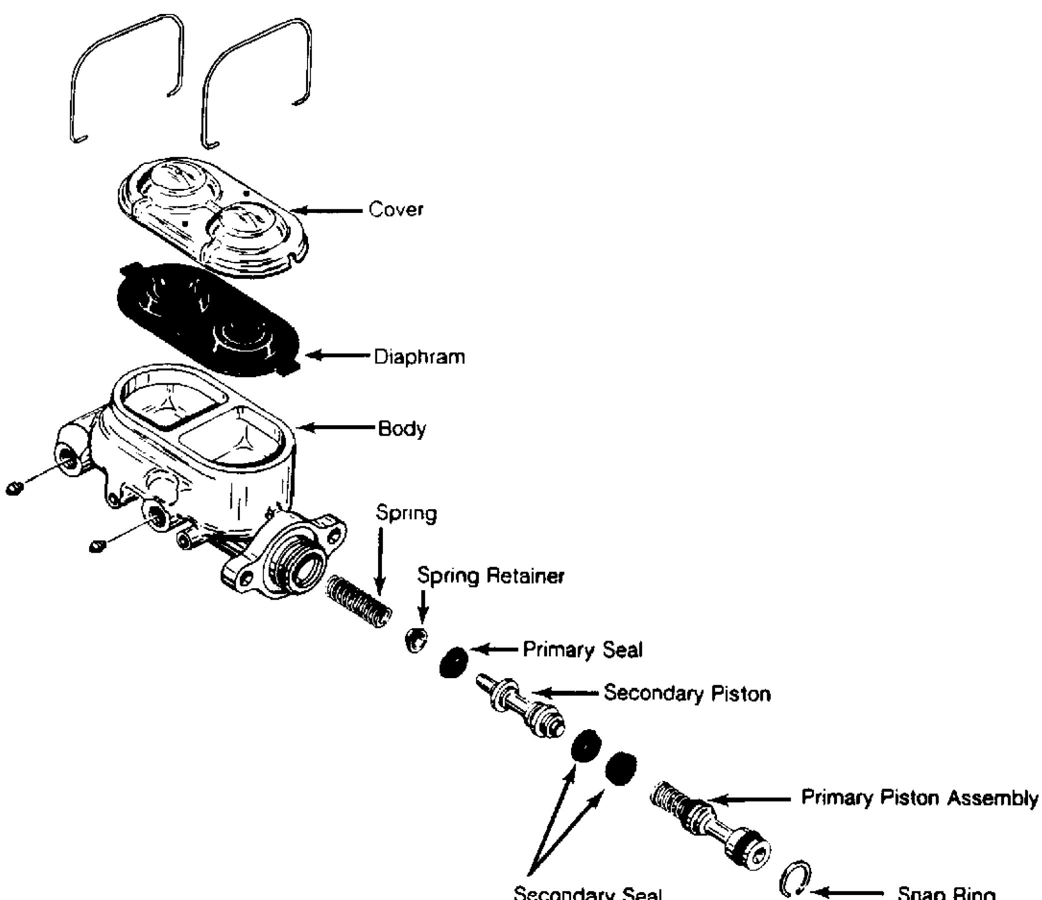

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Fig. 15: Exploded View of Master Cylinder (Grand Wagoneer)
Courtesy of American Motors/Jeep Corp.

WHEEL CYLINDER

Disassembly

Remove dust boots. Push pistons, piston cups and expander spring out of bore. Discard cups. Clean all parts with brake solvent. Inspect cylinder bore and piston for pitting, wear or damage. Replace as necessary. Light scoring or pitting may be removed by honing.

Reassembly

1) Lubricate cylinder bore and internal components with brake fluid. Do not lubricate dust boots. Position replacement piston cups on spring expanders. Install assembled parts in cylinder bore.

2) Ensure expanders are seated in piston cups. Cups are to be installed with lips facing each other. Install pistons with flat sides facing interior of bore. Install dust boots.

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS TABLE

Application	Ft. Lbs. (N.m)
Disc Brakes	
Caliper Mounting Bolts	35 (47)
Bleeder Screw	12 (16)
Brake Line-to-Caliper	13 (18)
Drum Brakes	
Wheel Cylinder Bolts	11 (15)
Bleeder Screw 1/4"	4-5 (5-7)
Bleeder Screw 3/8"	4-10 (5-14)
Brake Line	10-17 (14-23)
Backing Plate Bolt	30-40 (41-54)
Master Cylinder Retaining Nuts	
Except Grand Wagoneer	20 (27)

BRAKE SYSTEM SPECIFICATIONS

DISC BRAKE SPECIFICATIONS

DISC BRAKE SPECIFICATIONS TABLE

Application	In. (mm)
Cherokee, Comanche, Wagoneer & Wrangler	
Disc Diameter	11.02 (279.9)
Lateral Runout	0.005 (0.13)
Parallelism	0.001 (0.03)
Original Thickness	0.88 (22.4)
Min. Refinish Thickness	0.815 (20.70)
Discard Thickness	0.815 (20.70)
Grand Wagoneer	
Disc Diameter	12.00 (304.8)
Lateral Runout	0.005 (0.13)
Parallelism	0.001 (0.03)
Original Thickness	N/A
Min. Refinish Thickness	1.215 (30.86)
Discard Thickness	1.215 (30.86)

DRUM BRAKE SYSTEM SPECIFICATIONS

DRUM BRAKE SPECIFICATIONS TABLE

Application	In. (mm)
Cherokee, Comanche, Wagoneer & Wrangler	
Drum Diameter	10.00 (254.0)
Drum Width	1.75 (44.5)
Max. Drum Refinish Diam.	10.06 (255.5)
Wheel Cyl. Diameter	.875 (22.2)
Master Cyl. Diameter	.937 (23.8)
Grand Wagoneer	
Drum Diameter	11.00 (279.4)
Drum Width	2.00 (50.8)
Max. Drum Refinish Diam.	11.06 (280.9)
Wheel Cyl. Diameter	.937 (23.80)
Master Cyl. Diameter	1.125 (28.58)

1984-86 Computerized Engine Controls
JEEP 4-CYLINDER COMPUTERIZED ENGINE CONTROL
COMPONENT REMOVAL & INSTALLATION

Cherokee, CJ/Scrambler, Comanche, Wagoneer, Wrangler

MICROCOMPUTER CONTROL UNIT (MCU) R & I

The MCU is located behind the right front kick panel. Remove MCU mounting bolts and disconnect wiring harness connector. Do not bend connector pins when removing. Reconnect harness to MCU and replace mounting bolts.

MIXTURE CONTROL (M/C) SOLENOID R & I

Remove air cleaner and disconnect solenoid harness connector. Remove retaining screws and remove solenoid from carburetor. Coat rubber seal, on end of solenoid stem, with silicone grease or light engine oil prior to reinsertion. Using a new gasket, replace solenoid. Reconnect wiring harness and replace air cleaner.

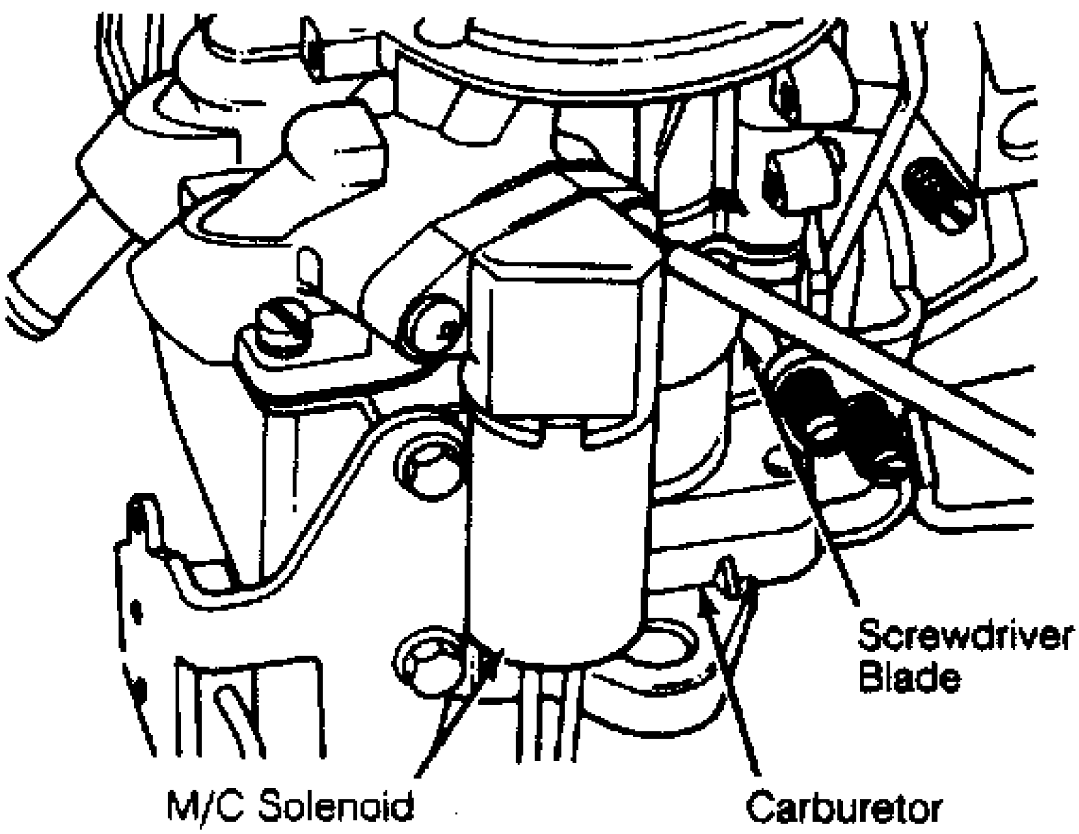

Fig. 1: M/C Solenoid Location on Carburetor

OXYGEN (O2) SENSOR R & I

Disconnect wire connector from oxygen sensor. Remove sensor from exhaust manifold. Clean threads in manifold. Coat threads of replacement sensor with anti-seize compound. Install new sensor in exhaust manifold and tighten to 32-38 ft. lbs. (43-51 N.m). Reconnect wire connector.

CLUTCH

1988 Jeep Cherokee

1988 Clutch
Hydraulic

Cherokee, Comanche, Wagoneer, Wrangler

DESCRIPTION

The clutch assembly consists of a single dry-disc driven plate and a one-piece diaphragm spring-type clutch cover. On Wrangler 4-cylinder models, the clutch cover and driven plate diameter is 9.28" (232 mm). On Wrangler 6-cylinder models, the clutch cover and driven plate diameter is 10.5" (266 mm). On all other 4 and 6-cylinder models, the clutch cover and driven plate diameter is 9.7" (246 mm). The clutch is actuated through a hydraulic master cylinder and slave cylinder.

On Wrangler models, the slave cylinder is mounted inside the clutch housing. The bearing is permanently attached to the cylinder piston.

TRANSMISSION APPLICATION

Vehicle Model	Transmission Model
Cherokee, Comanche, Wagoneer	Aisin AX4 4-Speed Aisin AX5 5-Speed O/D
Wrangler	Aisin AX5 5-Speed O/D Peugeot BA 10/5 5-Speed O/D

REMOVAL & INSTALLATION

TRANSMISSION

Removal

1) Remove the shift knob and lock nut from transmission and transfer case shift levers (if equipped). On Wrangler models, remove screws attaching transmission and transfer case shift lever boots and remove both boots.

2) On all other models, raise outer gearshift lever boot and remove upper part on center console. Remove lower part of console, remove inner boot and gearshift lever.

3) On Wrangler models, remove transmission shift tower dust cover. Remove transmission shift lever and stub shaft. DO NOT remove shift lever from stub shaft.

4) On all models, raise and support vehicle. Drain transmission lubricant. Mark rear drive shaft for reassembly and remove rear drive shaft. Support transmission assembly and remove crossmember. Disconnect speedometer cable and wiring from back-up light switch.

5) On 4WD models, drain transfer case lubricant. Disconnect transfer case vacuum hoses and linkage. Tag vacuum hoses for reassembly. Disconnect front drive shaft and secure out of way.

6) On all models, remove clutch slave cylinder. Position transmission jack under transmission assembly. Remove bolts securing clutch housing to engine and remove transmission assembly. Remove throw-out lever, bearing, and pivot ball from clutch housing.

Installation

To install, reverse removal procedure.

CLUTCH

Removal

Remove transmission assembly. Mark position of clutch cover on flywheel for reassembly reference. Evenly loosen clutch cover bolts one or 2 turns at a time until clutch cover spring tension is released. Remove cover bolts, clutch cover, and disc. See Fig. 1.

Installation

1) Check all components for wear or damage and replace as necessary. Using clutch alignment tool, align clutch disc and loosely install clutch cover. Be sure marks made during removal are aligned.

2) To avoid warping clutch cover, tighten each cover bolt a few turns at a time. To complete installation, reverse removal procedure.

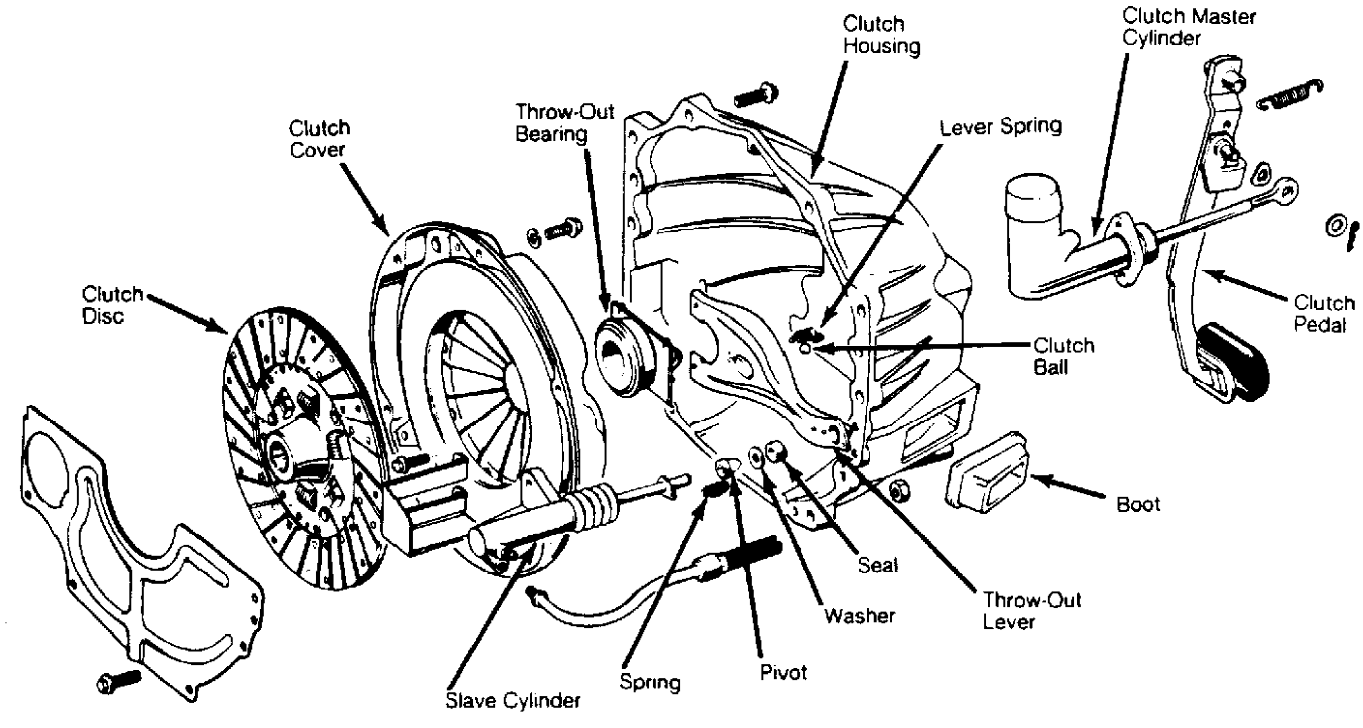

Fig. 1: Exploded View Of Cherokee, Comanche & Wagoneer Hydraulic Clutch Assembly
Wrangler has a one-piece slave cylinder.

CLUTCH MASTER CYLINDER

Removal

1) Disconnect hydraulic line at master cylinder. Plug openings to prevent dirt from entering system. Remove cotter pin and washer holding cylinder push rod on clutch pedal.

2) Slide push rod off pedal pivot. Remove nuts attaching clutch master cylinder to studs on dash panel and remove cylinder.

Installation

To install, reverse removal procedure. Bleed hydraulic system.

CLUTCH SLAVE CYLINDER

Removal (Wrangler)

1) Disconnect slave cylinder inlet line. Remove transmission and transfer case. Slide rubber insulator off slave cylinder lines. Remove bolts attaching insulator bracket to clutch housing. Slide bracket off cylinder lines.

2) Remove slave cylinder and bearing retaining nut. Pry nut up and off mounting pin on transmission front case. Remove slave cylinder and bearing by sliding assembly off transmission input shaft. See Fig. 2.

Installation

To install, reverse removal procedure. Bleed hydraulic system.

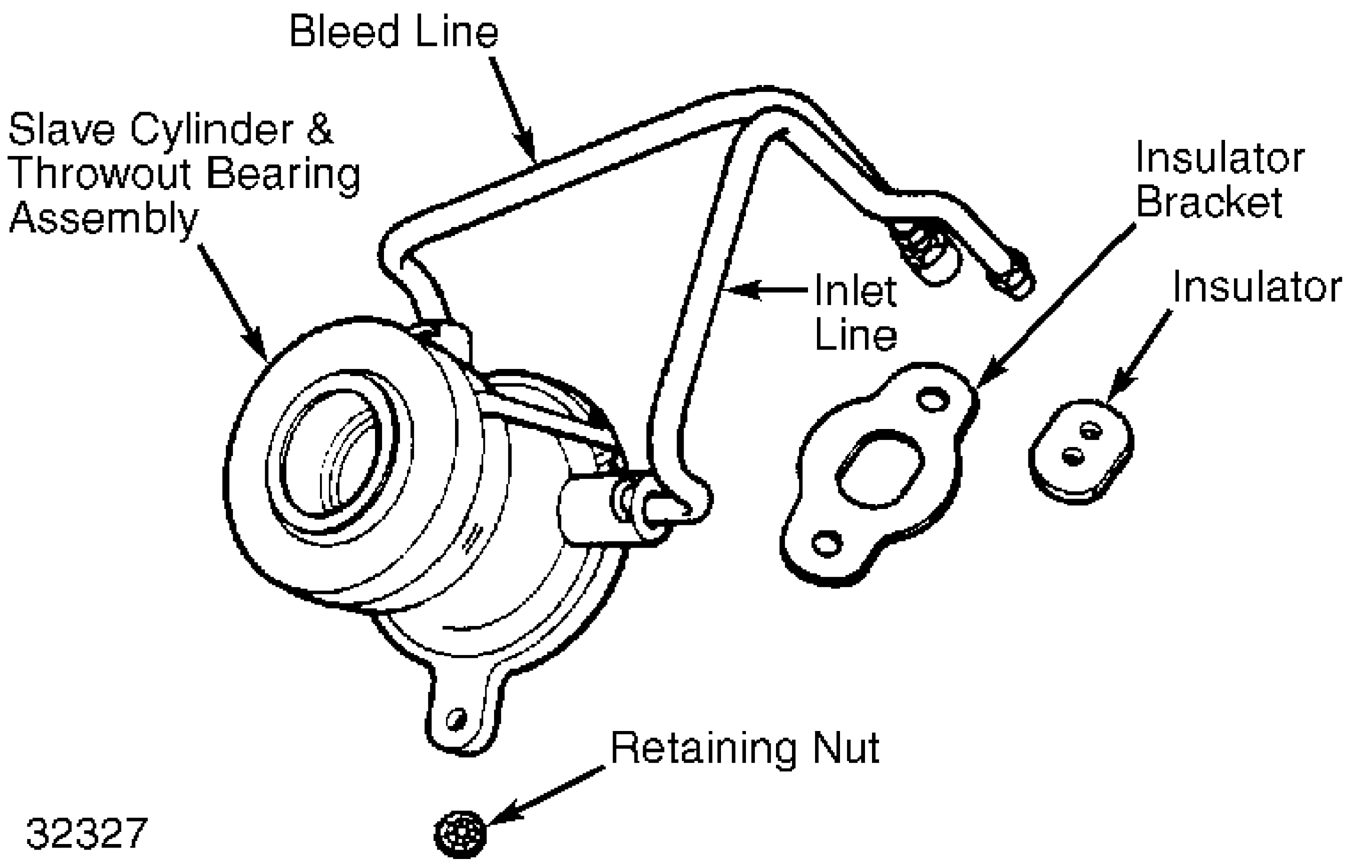

Fig. 2: Wrangler Clutch Slave Cylinder
Courtesy of Chrysler Motors.

Removal (Cherokee, Comanche & Wagoneer)

Disconnect hydraulic line at clutch slave cylinder. Cap line to prevent fluid loss. Remove spring holding clutch fork lever to cylinder push rod. Remove bolts attaching slave cylinder to clutch housing. Remove slave cylinder, heat shield, clutch fork pivot, washer and seal.

Installation

To install, reverse removal procedure. Bleed hydraulic system.

PILOT BUSHING

Removal (Cherokee, Comanche & Wagoneer)

Remove clutch assembly. Remove pilot bushing using Slide Hammer (J-2619-01) and Bushing Remover (J-5822).

Installation

Lubricate replacement bushing with engine oil. Remove pilot bushing lubricating wick and soak wick in engine oil. Install wick in bushing bore. Install bushing using Clutch Pilot Shaft (J-33169). Keep pilot shaft parallel with crankshaft center line to prevent damage to bushing. Reverse removal procedure to complete installation.

OVERHAUL

CLUTCH MASTER CYLINDER

Disassembly

1) Remove reservoir cap and cover. Remove push rod dust cover. Remove snap ring holding push rod in cylinder bore. Discard dust cover and snap ring.

2) Remove push rod, retaining washer, and seal as an assembly. Discard seal. Remove plunger, valve spring, and valve stem assembly from cylinder bore by tapping cylinder body on wood block.

3) Compress valve spring slightly. Pry tab of valve stem retainer upward to release retainer, spring and stem assembly from plunger. Remove seal from plunger and discard. Remove spring retainer and valve stem from valve spring.

NOTE: Retainer tab is located in rectangular slot in side of stem retainer.

4) Remove valve stem from retainer. Remove spring washer and stem tip seal from end of valve stem. See Fig. 3. Discard stem tip seal and spring washer. Clean parts with brake fluid or brake cleaning solvent.

5) Inspect cylinder bore for wear, nicks or scores. Master cylinder bore must be clean and smooth. Light discoloration is acceptable. Replace if necessary. Clutch master cylinder must not be honed under any circumstances.

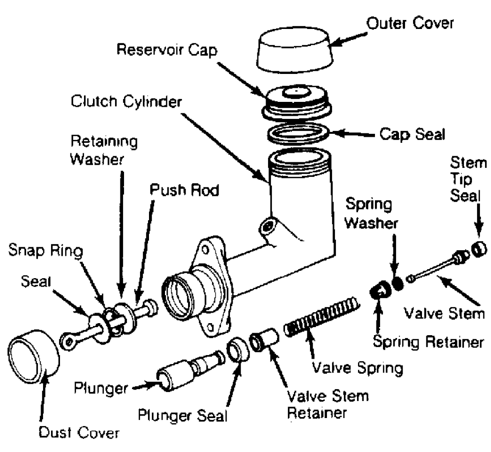

Fig. 3: Exploded View Of Clutch Master Cylinder
Courtesy of Chrysler Motors.

Reassembly

1) Lubricate cylinder bore with brake fluid. Make sure lip of

plunger seal faces stem end of plunger. Install stem tip seal so seal shoulder fits in undercut at end of valve stem.

2) End of valve stem should pass through stem retainer and seat in small bore in end of plunger. Bend retainer tab downward to lock stem and retainer on plunger. To complete assembly, reverse disassembly procedures.

CLUTCH SLAVE CYLINDER

Disassembly

NOTE: On Wrangler models, the integral slave cylinder and throw out bearing assembly is not serviceable. If cylinder, bearing or lines become damaged the entire assembly must be replaced.

1) Clean cylinder exterior. Remove dust boot from cylinder. Remove cylinder push rod, plunger and spring as an assembly. Remove spring seal from plunger.

2) Remove snap ring holding push rod in plunger. Remove push rod and boot. Remove boot from push rod. See Fig. 4. Clean parts with brake fluid or brake cleaning solvent. Inspect cylinder bore for wear, nicks or scores. Replace if necessary.

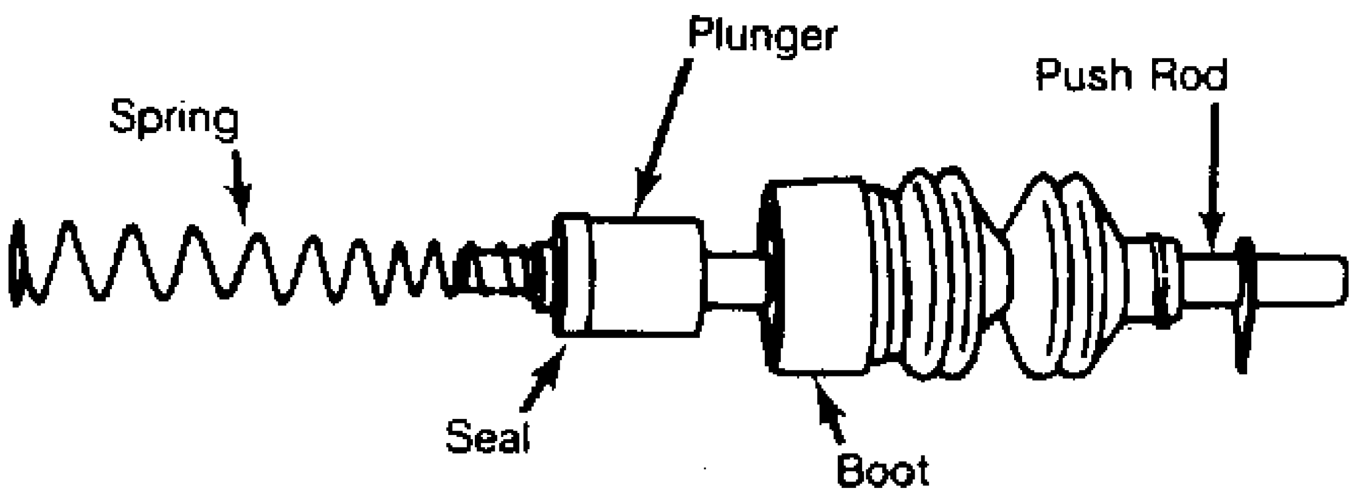

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Fig. 4: Exploded View Of Clutch Slave Cylinder
Courtesy of Chrysler Motors.

Reassembly

Reverse disassembly procedure. Lubricate cylinder bore and seal with brake fluid before reassembly.

HYDRAULIC SYSTEM BLEEDING

1) Fill master cylinder reservoir with DOT 3 brake fluid. On all models except Wrangler, compress slave cylinder plunger by pushing release lever as far forward as possible.

2) Attach rubber hose to slave cylinder bleeder screw. Immerse other end of hose in glass container 1/2 full of brake fluid. Loosen bleeder screw and have an assistant depress clutch pedal. Tighten bleeder screw and release pedal.

3) Repeat bleeding procedure until fluid entering container is free of bubbles. DO NOT allow reservoir to run out of fluid during

bleeding. Refill clutch master cylinder to level mark on reservoir.

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS TABLE

Application	Ft. Lbs. (N.m)
Cherokee, Comanche & Wagoneer	
Bellhousing-to-Engine Bolts	28 (38)
Clutch Cover Bolts	23 (31)
Crossmember-to-Sill Bolts	30 (41)
Flywheel Bolts	
4-Cylinder	(1) 50 (68)
6-Cylinder	61-75 (83-102)
Master Cylinder Attaching Nuts	19 (26)
Rear Support-to-Engine Bolt	33 (45)
Slave Cylinder-to-Clutch Housing Bolts	16 (22)
Transmission Drain Plug	27 (37)
Wrangler	
Bellhousing-to-Engine Bolts	28 (38)
Clutch Cover Bolts	
4-Cylinder	23 (31)
6-Cylinder	40 (54)
Crossmember-to-Sill Bolts	30 (41)
Master Cylinder Attaching Nuts	19 (26)
Rear Support-to-Crossmember Bolts	33 (45)
Transmission Drain Plug	27 (37)

(1) - Plus additional 60 degrees turn after reaching torque specification.

COMPUTER RELEARN PROCEDURES

1988 Jeep Cherokee

GENERAL INFORMATION
Computer Relearn Procedures

All Models

* PLEASE READ THIS FIRST *

The following general procedures are to be used if driveability problems are encountered after power loss or battery has been disconnected. These procedures may provide an aid in eliminating these problems.

To reduce the possibility of complaints, after any service which requires battery power to be disconnected, vehicle should be road tested.

COMPUTER RELEARN PROCEDURES

Vehicles equipped with engine or transmission computers may require a relearn procedure after vehicle battery is disconnected. Many vehicle computers memorize and store vehicle operation patterns for optimum driveability and performance. When vehicle battery is disconnected, this memory is lost. The computer will use default data until new data from each key start is stored. As computer memorizes vehicle operation for each new key start, driveability is restored. Vehicle computers may memorize vehicles operation patterns for 40 of more key starts.

Customers often complain of driveability problems during relearn stage because vehicle acts differently then before being serviced. Depending on type and make of vehicle and how it is equipped, the following complaints (driveability problems) may exist:

* Harsh Or Poor Shift Quality
* Rough Or Unstable Idle
* Hesitation Or Stumble
* Rich Or Lean Running
* Poor Fuel Mileage

These symptoms and complaints should disappear after a number of drive cycles have been memorized. To reduce the possibility of complaints, after any service which requires battery power to be disconnected, vehicle should be road tested. If a specific relearn procedure is not available, the following procedure may be used:

Automatic Transmission

* Set parking brake, start engine in "P" or "N" position. Warm-up vehicle to normal operating temperature or until cooling fan cycles.
* Allow vehicle to idle for one minute in "N" position. Select "D" and allow engine to idle for one minute.
* Accelerate at normal throttle position (20-50%) until vehicle shifts into top gear.
* Cruise at light to medium throttle.
* Decelerate to a stop, allowing vehicle to downshift, and use brakes normally.
* Process may be repeated as necessary.

Manual Transmission

* Place transmission in Neutral position.
* Ensure emergency brake has been set and all accessories are turned off.
* Start engine and bring to normal operating temperature.
* Allow vehicle to idle in Neutral for one minute.
* Initial relearn is complete: process will be completed during normal driving.

Some manufacturers identify a specific relearn procedure which will help establish suitable driveability during relearn stage. These procedures are especially important if vehicle is equipped with and electronically controlled automatic transmission or transaxle. Always complete procedure before returning vehicle to customer.

COOLING SYSTEM SPECIFICATIONS

1988 Jeep Cherokee

1988 ENGINE COOLING
Jeep Cooling System Specifications

Cherokee, Comanche, Wagoneer, Wrangler, Grand Wagoneer

MAINTENANCE SCHEDULE

Change engine coolant every 12,500 miles or 12 months. Thereafter change engine coolant at the beginning of every winter season. Maintain ethylene glycol and water solution at a mixture of 50/50.

COOLING SYSTEM SPECIFICATIONS TABLE

Application	Capacity Quarts(L)
2.5L	
Thermo. Temp. °F (°C)	192-198 (89-92)
Rad. Cap PSI	12-15
Coolant Capacity Qts. (L)	(1) 10 (9.4)
4.0L	
Thermo. Temp. °F (°C)	192-198 (89-92)
Rad. Cap PSI	12-15
Coolant Capacity Qts. (L)	12 (11.3)
4.2L	
Thermo. Temp. °F (°C)	192-198 (89-92)
Rad. Cap PSI	12-15
Coolant Capacity Qts. (L)	(2) 10.5 (9.9)
6.0L	
Thermo. Temp. °F (°C)	192-198 (89-92)
Rad. Cap PSI	12-15
Coolant Capacity Qts. (L)	14 (14 (13.2)

(1) - Without A/C 23 qts. (2.1L) for recovery tank.
(2) - Includes 1 qt. (.9L) for recovery tank.

CRUISE CONTROL SYSTEM

1988 Jeep Cherokee

1988 Cruise Control Systems
JEEP CRUISE COMMAND

All Models

DESCRIPTION & OPERATION

Jeep vehicles use an electro-mechanical servo system. The system consists of a control module, speed sensor, servo, control switch assembly, vacuum storage canister, check valve and release system. Release system consists of a mechanical vacuum vent valve and brake and clutch (M/T) release switches.

Cruise control switch is an integral part of turn signal switch lever and consists of 2 separate switches. First is an "ON-OFF" and "RESUME" slide switch located on flat of directional switch lever.

Second is "SET/COAST" push button switch located at end of directional switch lever. To engage system, move slide switch to "ON" position and accelerate to desired speed. Depress and release "SET/COAST" button on end of switch lever. System will now maintain selected speed.

System will automatically disengage when brake or clutch pedal is depressed. It can be re-engaged to previously selected speed by accelerating to 30 MPH and moving slide switch to "RESUME" position, then releasing switch.

NOTE: When slide switch is moved to "OFF" position, pre-set speed of "RESUME" function is canceled from memory and must be reset when system is reactivated.

Higher speed can be set by pressing on accelerator pedal until new speed is reached and then pushing "SET/COAST" button. Lower speed can be obtained by lightly depressing brake pedal, allowing the vehicle to slow to desired speed and then depressing and releasing "SET/COAST" button.

CONTROL MODULE

Control module receives input voltage representing vehicle speed from speed sensor, which is driven by the speedometer cable. Control module has a low speed circuit that prevents operation at speeds below 30 MPH. See Fig. 1.

SERVO

Servo is controlled by control module and uses manifold vacuum to control throttle. Bead-link chain connects servo cable to throttle linkage. See Fig. 1.

CONTROL SWITCH

Control switch assembly is an integral part of turn signal switch lever. See Fig. 1.

RELEASE SYSTEM

Release system deactivates cruise control system when brake or clutch pedal is depressed. Either servo vent valve or mechanical vacuum vent switch admits atmospheric pressure into servo when brake pedal is depressed.

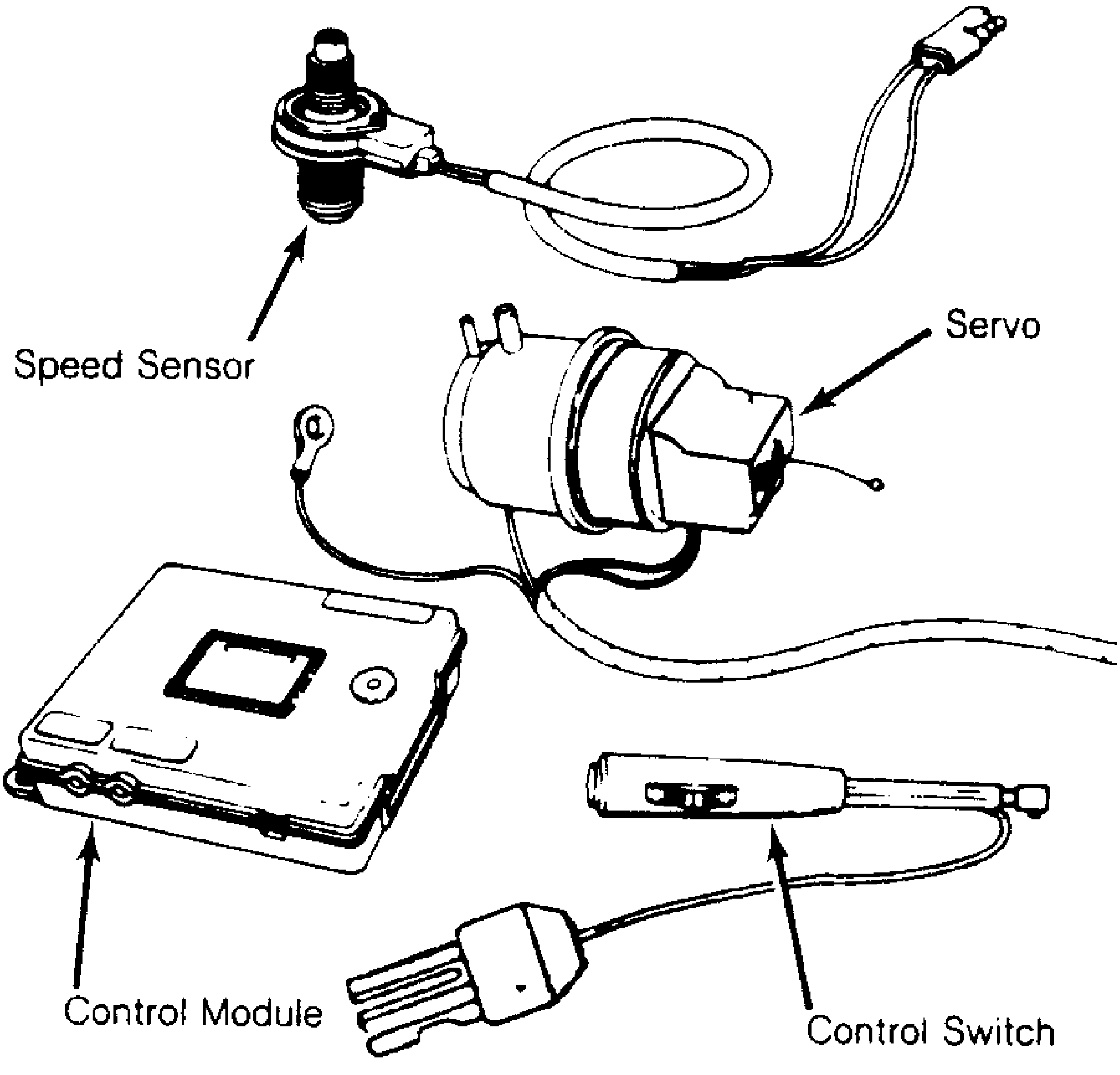


Fig. 1: Cruise Control System Components
Courtesy of Chrysler Motors.

TROUBLE SHOOTING

NOTE: Vehicles with computerized engine controls, should be tested for stored computer codes. Codes and related problems must be repaired prior to cruise control diagnosis and repair. For additional information, see COMPUTERIZED ENGINE CONTROLS section.

SYSTEM WILL NOT ENGAGE

Restricted vacuum hose or no vacuum. Control switch or control module defective. Speed sensor defective. Clutch or brake light switch defective or misadjusted. Brake light switch wire disconnected. Open circuit between brake light switch and brake lights.

RESUME FEATURE INOPERATIVE

Defective servo ground connection. Defective control switch.

ACCELERATE FUNCTION INOPERATIVE

Accelerate circuit in control module inoperative. Defective control switch.

SYSTEM RE-ENGAGES WHEN BRAKE PEDAL IS RELEASED

Defective control module. Mechanical vent valve not opening. Kink in mechanical vent valve hose. Brake light switch defective.

CARBURETOR THROTTLE DOES NOT RETURN TO IDLE POSITION

Improper linkage adjustment.

ROAD SPEED CHANGES 2 MPH OR MORE WHEN SETTING SPEED

Centering adjustment wrong. Servo link misadjusted.

ENGINE ACCELERATES WHEN STARTED

Improper servo chain adjustment. Vacuum hose connections reversed at servo. Defective servo.

SYSTEM DISENGAGES ON LEVEL ROAD WITHOUT APPLYING BRAKES

Loose wire connection. Loose vacuum hose connection. Servo linkage broken. Defective brake light switch.

ERRATIC OPERATION

Reverse polarity of system wiring. Defective servo. Defective control module.

VEHICLE CONTINUES TO ACCELERATE WHEN "SET" BUTTON IS RELEASED

Servo or control module defective.

SYSTEM ENGAGES BUT SLOWLY LOSES SET SPEED

Air leak at connections or in vacuum hoses. Air leak on vent valve on brake pedal.

ADJUSTMENTS

CONTROL MODULE ADJUSTMENT

NOTE: Control module adjustments are preset by manufacturer. If other components in system appear to be functioning properly

and cruise control remains inoperative, perform following adjustments to determine if control module is functional.

1) Remove control module attaching screws or tie straps and move control module downward for adjustment access. Turn centering adjustment screw to 10 o'clock position. Turn low speed adjustment screw to 10 o'clock position. Turn sensitivity adjustment screw fully clockwise.

CAUTION: Adjustment potentiometers are extremely delicate. Carefully insert screwdriver and do not push or turn screws excessively hard. Maximum movement is 3/4 turn.

2) Adjustments are not precisely correct for vehicle, but are acceptable to determine if control module is functioning. Perform precise adjustments by road testing vehicle on level road. If adjustments have no effect on cruise control, replace control module.

3) If actual engagement speed is 2 MPH or more above selected speed, stop vehicle and turn centering screw 1/16 of a turn counterclockwise. Recheck engagement speed and adjust as necessary.

4) If engagement speed is 2 MPH or more below selected speed, turn centering screw 1/16 of a turn clockwise. Recheck engagement speed and adjust as necessary.

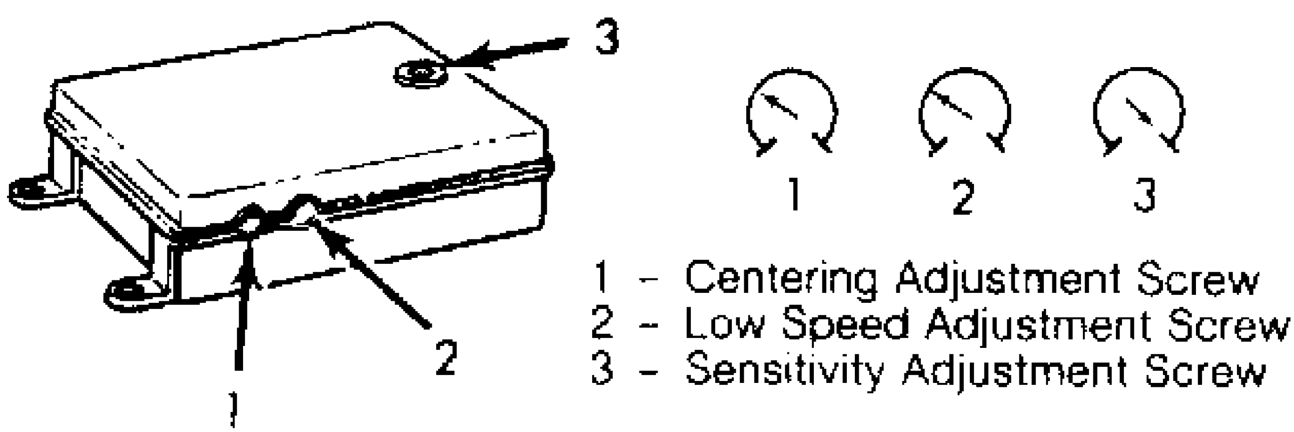


Fig. 2: Control Module Adjustment Screws
Courtesy of Chrysler Motors.

VACUUM VENT VALVE

Depress brake or clutch pedal and hold in depressed position. Move vacuum vent valve toward bracket on pedal as far as possible. Release brake or clutch pedal.

TESTING

NOTE: Vehicles with computerized engine controls, should be tested for stored computer codes. Codes and related problems must be repaired prior to cruise control diagnosis and repair. For additional information, see COMPUTERIZED ENGINE CONTROLS section.

PRELIMINARY INSPECTION

Ensure cruise control wire harness is properly connected to

control module before starting diagnosis or repair procedure, as this connection is disturbed when Cruise Command System Tester (AM PC-1-R) is used. Poor connection at this point may be improperly diagnosed as control module malfunction.

Brake light and clutch switches should be properly adjusted. Ensure that all vacuum lines are correctly routed and tightly connected.

CRUISE COMMAND SYSTEM TESTS

Testing is performed with Cruise Command System Tester (AM PC-1-R). Remove wire harness connector from control module. Connect tester to wire harness connector. Perform tests as part of service diagnosis to determine cause and correction of system malfunction. Various tester lights are associated with specific components, circuits, etc.

CONTROL SWITCH CONTINUITY

Wrangler

NOTE: Voltage checks should show battery voltage. If resistance readings are incorrect, check circuit for an open or a short. Cruise control module terminal No. 1 grounds through connector at engine block.

Light No. 1 "OFF" (Set Switch)

With control switch in "ON" position, check for battery voltage between HAZ/STOP and in-line fuse, terminal No. 14 and ground terminal No. 1

Light No. 2 "OFF" (Control Switch & Speed Sensor)

With control switch in "ON" position, check for battery voltage between HAZ/STOP and in-line fuse, terminal No. 5 and ground terminal No. 1. With ignition switch in "OFF" position, check resistance between terminals No. 2 and No. 3. Resistance should be 15-50 ohms.

Light No. 3 "OFF" (Brake Light Ground)

With ignition switch in "ON" position, install jumper wire between terminals No. 7 and No. 13. If brake lights do not turn on, check fuses and brake light switch connections.

Light No. 4 "OFF" (Throttle Position Feedback Sensor)

With ignition switch in "ON" position, check for battery voltage between gauge fuses at terminals No. 7 and No. 1.

With ignition switch in "OFF" position, check resistance between terminals No. 2 and No. 11. Resistance should be 2400-4000 ohms. At idle resistance should be 2800-4300 ohms and at wide open throttle resistance should be 4000 ohms.

Light No. 5 "OFF" (Resume/Accel/Vent Valve)

With control switch in "RESUME/ACCEL" position, check for battery voltage between HAZ/STOP and in-line fuse, terminal No. 10 and ground terminal No. 1. With ignition switch in "OFF" position, check resistance between terminals No. 6 and No. 12. Resistance should be 30-50 ohms. Resistance between terminals No. 6 and ground, and terminal No. 12 and ground should be infinite (open).

Light No. 6 "OFF" (Resume/Accel/Charge Valve)

With control switch in "RESUME/ACCEL" position, check for battery voltage between HAZ/STOP and in-line fuse, terminal No. 10 and ground terminal No. 1. With ignition switch in "OFF" position, check resistance between terminals No. 4 and No. 12. Resistance should be

30-50 ohms. Resistance between terminals No. 4 and ground, and terminal No. 12 and ground should be infinite (open).

WRANGLER CRUISE CONTROL TESTING

Conditions	Lights "ON"
Control Switch "ON" & Set Switch Depressed	No. 1
Control Switch "ON"	No. 2
Ignition "ON" & Brake or Clutch Pedal Depressed	No. 3 & No. 4
Cruise Control & Resume/Accel "ON"	No. 5 & No. 6
Cruise & Resume/Accel "ON" & Engine Running (1)	No. 5 & No. 6

(1) - Servo will pull throttle wide open. Keep RPM at a safe level by releasing cruise control switch.

Except Wrangler

Use 12-volt test light to test control switch continuity. Connect test light to wires as indicated in CONTROL SWITCH CONTINUITY TEST CHART. See Figs. 3 or 4.

SET/COAST (S/C) SW	POSITION SLIDER	1-2	1-3	1-4	2-3	2-4	3-4
Normal	Off	O	O	O	O	O	O
Normal	On	O	O	O	O	C	O
Normal	R/A	C	O	C	O	C	O
Depressed	Off	O	O	O	C	O	O
Depressed	On	O	O	O	C	C	C
Depressed	R/A	C	C	C	C	C	C

C - Closed

O - Open

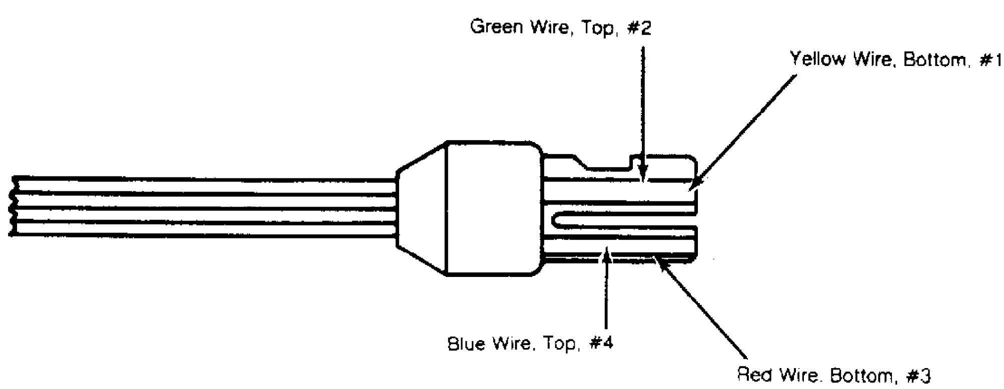


Fig. 3: Cherokee, Comanche & Wagoneer Control Switch Continuity Test Chart
Courtesy of Chrysler Motors.

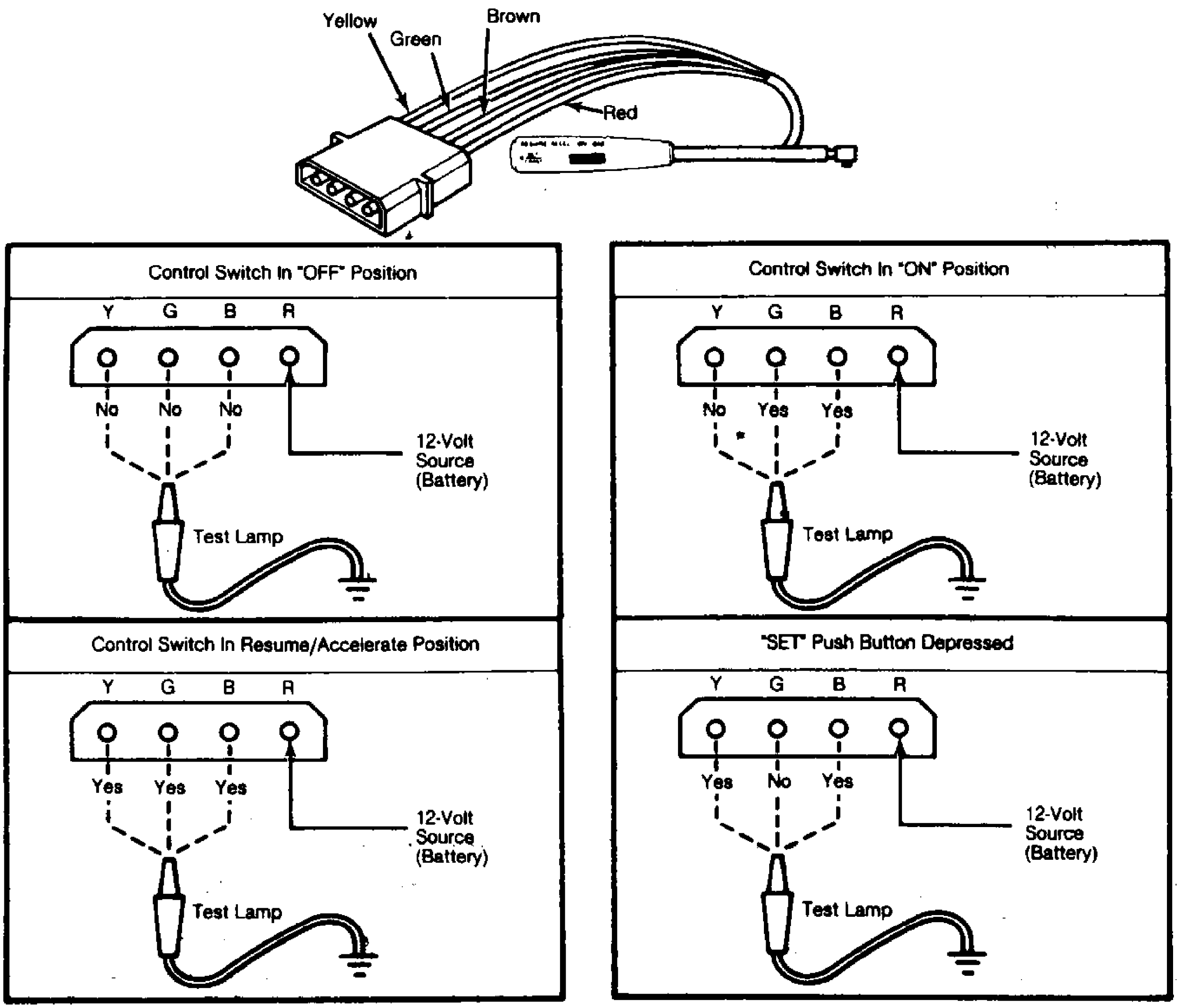


Fig. 4: Grand Wagoneer Control Switch Continuity Test Chart
Courtesy of Chrysler Motor.

CORRECT POWER SOURCE

Cherokee, Comanche & Wagoneer

1) With ignition switch and control switch "OFF", all test lights should be off. If any light is on, check Brown (7) wire is not connected directly to source of voltage.

2) Check for bad control switch. With ignition switch in "OFF" position, and control switch "ON". Light No. 2 should be on and lights No. 1, 3, 4, 5 and 6 should be off.

3) If light No. 2 is off, check speed sensor continuity, check speed sensor terminals to Gray and Drk. Blue wires, and check that terminals No. 2, 3, 5 and 7 (Gray, Drk. Blue and Lt. Green wires are not grounded).

Grand Wagoneer

With ignition and control switches in "OFF" position, test lights should be off. If one or more lights are on, remove Brown (5) wire at control module connector and check for direct source of voltage or repair defective control switch.

SYSTEM ELECTRICAL CONTINUITY

Cherokee, Comanche & Wagoneer

1) With ignition and control switches in "ON" position, lights No. 2, 3 and 4 should be on. Lights No. 1, 5 and 6 should be off. If light No. 2 is off, check speed sensor continuity, check speed sensor terminals to Gray and Drk. Blue wires, and check terminals No. 2, 3, 5 and 7 (Gray, Drk. Blue and Lt. Green wires are not grounded).

2) If light No. 3 is off, check brake light switch and all Brown, Lt. Blue and Lt. Green wire connections. If light No. 4 is off, check terminals No. 2 and No. 11 at control module connector. Check continuity of throttle position feedback rheostat of servo.

Grand Wagoneer

1) With ignition and control switches in "ON" position, lights No. 1, 2, 3, and 4 should be on. Lights No. 5 and 6 should be off. If light No. 1 is off, check for blown fuse in brake light switch to control switch circuit. Check Red, Brown and Green wires at control switch for continuity to switch. Check Drk. Green wire (14) at control module connector for continuity to control module.

2) If light No. 2 is off, check speed sensor for correct output voltage. Check Gray and Drk. Blue wire at speed sensor connector for continuity to control module connector. Check terminals No. 2, 3, 5 and 7 at control module connector for proper connection to wires.

3) If light No. 3 is off, check brake and clutch switch adjustment. If light No. 4 is off, check for defective connection at terminals No. 2 and 11 on control module connector. Check operation of throttle position feedback rheostat on servo.

COAST CONTINUITY TEST

Cherokee, Comanche & Wagoneer

1) With ignition and control switches in "ON" position, depress and hold "SET/COAST" button. Lights No. 1, 2, 3 and 4 should be on. Lights No. 5 and 6 should be off. If light No. 1 is off, check voltage from brake light switch, check 4-amp in-line fuse of Pink wire, and check Pink, Brown and Drk. Green wires at control switch connector and Drk. Green (14) wire at control module connector for good connections.

2) If light No. 2 is off, check speed sensor continuity, check speed sensor terminals to Gray and Drk. Blue wires, and check terminals No. 2, 3, 5 and 7 (Gray, Drk. Blue and Lt. Green wires) for ground.

3) If light No. 3 is off, check brake light switch, check all Brown, Lt. Blue and Lt. Green wire connections. If light No. 4 is off, check terminals No. 2 and 11 at control module connector, and check continuity of throttle position feedback rheostat of servo.

SERVO CHARGE VALVE SOLENOID CONTINUITY

CAUTION: If engine is running, servo will move throttle to wide open position.

Grand Wagoneer

1) With ignition and control switches in "ON" position, depress and hold "SET/COAST" button. Lights No. 2, 3, 4, 5 and 6 should be on. Light No. 1 should be off. Light No. 4 will dim when

servo moves throttle to wide open position with engine operating.
2) If light No. 2 is off, check speed sensor for correct output voltage. Check Gray and Drk. Blue wire at speed sensor connector for continuity to control module connector. Check terminals No. 2, 3, 5 and 7 at control module connector for proper connection to wires.
3) If light No. 3 is off, check brake and clutch switch adjustment. If light No. 4 is off, check for defective connection at terminals No. 2 and 11 on control module connector. Check operation of throttle position feedback rheostat on servo.
4) If light No. 5 is off, check for defective connections at terminals No. 4 and 12 on control module connector. If necessary, replace defective servo. If light No. 6 is off, check for defective connection at terminals No. 6 and 12 on control module connector. If necessary, replace defective servo.
5) If all lights are off after depressing set/coast speed switch, check for blown fuse. Check for short circuits in Red, Pink and Brown wire circuits at control switch. If necessary, replace defective servo.

SYSTEM DISENGAGEMENT WITH BRAKE PEDAL DEPRESSED

Cherokee, Comanche & Wagoneer
1) With ignition and control switches in "ON" position and brake pedal depressed, lights No. 2 and 4 should be on. Lights No. 1, 3, 5 and 6 should be off. Light No. 3 should be on when brake pedal is released.
2) If light No. 2 is off, check speed sensor continuity, check speed sensor terminals to Gray and Drk. Blue wires, and check terminals No. 2, 3, 5 and 7 (Gray, Drk. Blue and Lt. Green) for ground.
3) If light No. 4 is off, check terminals No. 2 and 11 at control module connector, and check continuity of throttle position feedback rheostat of servo.

Grand Wagoneer
1) With ignition and control switches in "ON" position and brake pedal depressed, lights No. 1, 2 and 4 should be on. Lights No. 3, 5 and 6 should be off. Light No. 3 should be on when brake pedal is released.
2) If light No. 1 is off, check for blown fuse in brake light switch to control switch circuit. Check Red, Brown and Green wires at control switch connector for continuity to switch. Check Drk. Green wire (14) at control module connector for continuity to control module.
3) If light No. 2 is off, check speed sensor for correct output voltage. Check Gray and Drk. Blue wire at speed sensor connector for continuity to control module connector. Check terminals No. 2, 3, 5 and 7 at control module connector for proper connection to wires.
4) If light No. 4 is off, check for defective connection at terminals No. 2 and 11 on control module connector. Check operation of throttle position feedback rheostat on servo. If light No. 3 is off when brake pedal is released, check brake light switch adjustment.

"RESUME/ACCEL" FUNCTION

CAUTION: If engine is running, servo will move throttle to wide open position.

Cherokee, Comanche & Wagoneer
1) With ignition and control switches in "ON" position, slide and hold control switch in "R/A" position. Lights No. 2, 3, 4, 5 and 6

should be on. Light No. 1 should be off. Light No. 4 will dim when servo moves throttle to wide open position, if engine is running.

2) If light No. 2 is off, check speed sensor terminal connections to control module through Gray and Drk. Blue wires. Check terminals No. 2, 3, 5 and 7 (Gray, Drk. Blue and Lt. Green wires) for ground.

3) If light No. 3 is off, check brake light switch, and check all Brown, Lt. Blue and Lt. Green wire connections. If light No. 4 is off, check terminals No. 2 and 11 at control module connector. Check continuity of throttle position feedback rheostat of servo.

4) If light No. 5 is off, check for bad connection at White (6) and Orange (12) wire terminals. If necessary, replace defective servo.

5) If all lights are off after moving control switch to "R/A" position, check for blown fuse or fuses, and check Red, Pink, Brown or White wires for shorts. If necessary replace defective servo.

Grand Wagoneer

1) With ignition and control switches in "ON" position, slide control switch to "R/A" position. All test lights should be on. Light No. 4 will dim when servo moves throttle to wide open position, if engine is running.

2) If light No. 1 is off, check for blown fuse in brake light switch to control switch circuit. Check Red, Brown and Green wires at control switch for continuity to switch.

3) If light No. 2 is off, check Gray and Drk. Blue wire at speed sensor connector for continuity to control module connector.

4) If light No. 3 is off, check brake light switch adjustment. If light No. 4 is off, check for defective connection at terminals No. 2 and 11 on control module connector. Check operation of throttle position feedback rheostat on servo.

5) If light No. 5 is off, check for defective connections at terminals No. 4 and 12 on control module connector. If necessary, replace defective servo. If light No. 6 is off, check for defective connection at terminals No. 6 and 12 on control module connector. If necessary, replace defective servo.

6) If all lights are off after moving control switch to "R/A" position, check for blown fuse. Check for short circuits in Red, Pink and Brown wire circuits at control switch. If necessary, replace defective servo.

SPEED SENSOR TEST

1) Disconnect wire harness connector at speed sensor. Connect a voltmeter (set on low AC scale) to terminals from speed sensor.

2) Raise front and rear wheels of vehicle off ground and support vehicle with safety stands. Run engine (wheels spinning freely) at 30 MPH and note voltage.

3) Voltage should be approximately .9 volts. Increases of .1 volts per each 10 MPH increase in speed should also be noticed. Turn off engine and stop wheels. Lower vehicle. Connect speed sensor wire harness.

SERVO TEST

1) With ignition switch in "OFF" position, disconnect servo wire harness connector. Remove vacuum hose from brake pedal vent valve nipple on servo. Disconnect servo cable from throttle linkage at carburetor.

2) Connect an ohmmeter between ground and Red. Ground and Orange. And Ground and White wire terminals of servo wire harness connector. See Fig. 5. Observe ohmmeter during each test. An infinite (open circuit) resistance should be indicated for each wire terminal.

3) If ohmmeter indicates less than infinite resistance on any terminal, servo has short circuit to ground and must be replaced. Short circuit will also cause damage to control module and it must be replaced.

NOTE: Without sufficient load, solid state circuitry in control module will be damaged by excessive current flow.

4) If servo does not have any short circuits to ground, connect a vacuum gauge to brake pedal vent valve nipple. Connect a jumper wire from chassis ground to Orange wire terminal of servo wire harness connector.

5) Connect a second jumper wire to battery positive terminal and start engine. Momentarily connect jumper wire and simultaneously touch Red and White wire terminals in servo wire harness connector.

6) Vacuum should be indicated on gauge while jumper wire is in contact with wire terminals. Perform this test several times to make sure that solenoid valves are working properly.

7) With no voltage applied, solenoid charge valve is closed and solenoid vent valve is open. With 12 volts applied, solenoid charge valve is open and vent valve is closed.

8) Turn engine off and remove jumper wires. If servo is defective, replace it. If okay, connect vacuum hose, wire harness connector and throttle linkage to servo.

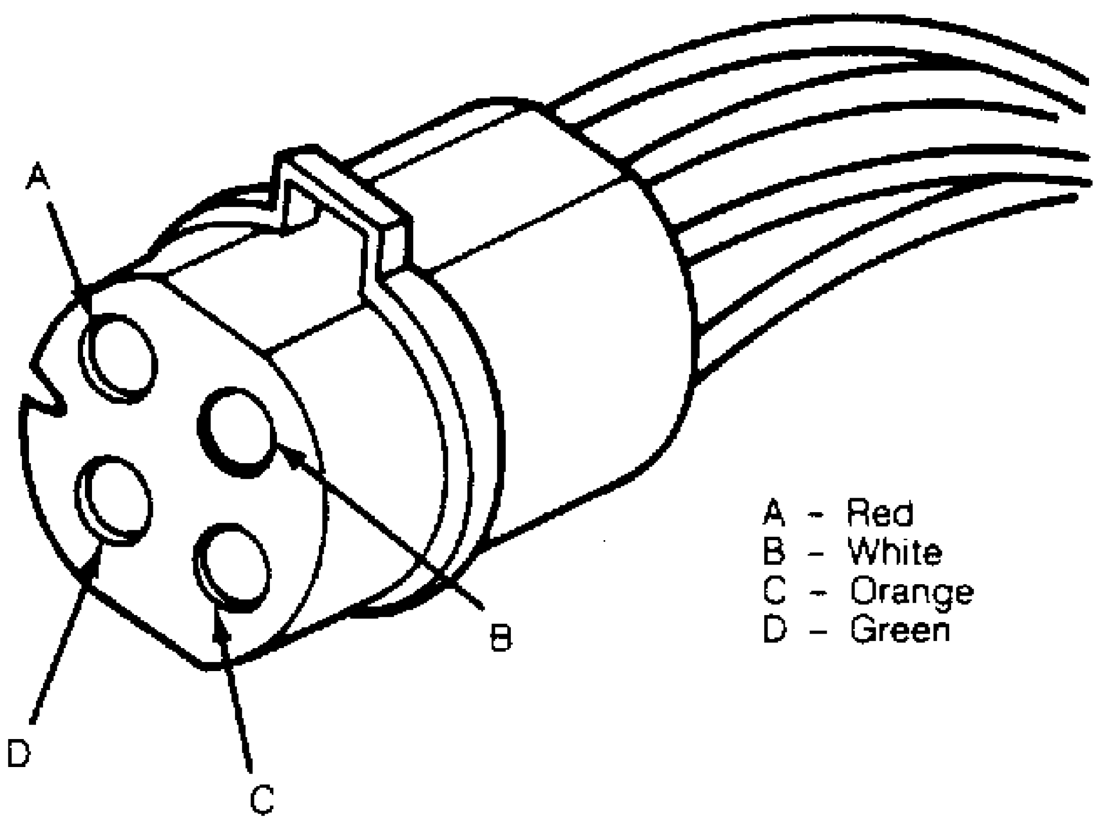


Fig. 5: Servo Wire Harness Connector (Except Grand Wagoneer)
Courtesy of Chrysler Motors.

DEFOGGER - REAR WINDOW

1988 Jeep Cherokee

1988 Defoggers
REAR WINDOW

Jeep: All Models

DESCRIPTION & OPERATION

System consists of 2 vertical bus bars and horizontal rows of heating elements fused to inside of glass, a control switch, an indicator light, and timer relay.

The grid feed wire is connected to bus bar on driver's side of window. Ground bus bar is on right side of vehicle. Timer/relay receives current from fuse block. A circuit breaker protects defogger circuit.

NOTE: On some Jeep models, defogger switch and electric tailgate switch are serviced as an assembly.

TROUBLE SHOOTING

NOTE: Control switch testing is not available for Wrangler models.

1) On Cherokee, Comanche and Wagoneer models, turn ignition switch to "ON" position. Check for current at "I" and "B" terminals. See Fig. 1. If there is no current, check circuit and repair as necessary. Make sure that switch has a good ground through wire connected to "G" terminal.

2) With a good ground circuit and ignition switch in "ON" position, current should be present at "L" terminal. If there is no current, replace control switch.

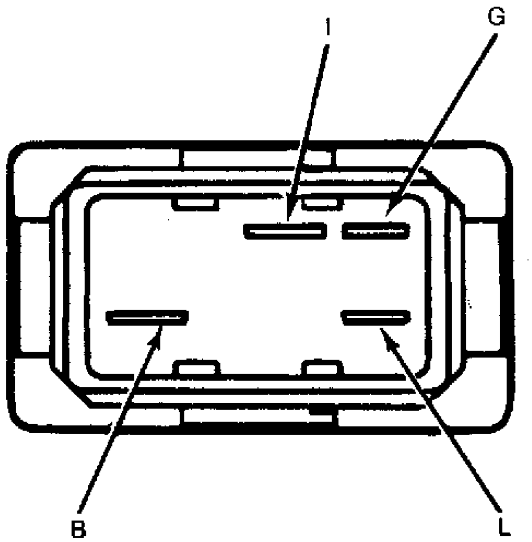


Fig. 1: Jeep Control Switch Terminals

3) On Grand Wagoneer models, turn ignition switch to "ON" position and press defogger switch. Separate wiring harness at connector under dash. Connect a 12-volt test light from Purple wire to

ground. Test light should light. Turn defogger switch to "OFF" position. Test light should not light.

GRID

1) Using a voltmeter with a 0-15 volt range, contact bus bar connecting grid lines on passenger's side of glass with negative lead of voltmeter. Contact driver's side bus bar with positive lead.

2) Turn ignition and control switches to "ON" position. Reading should be 10-14 volts. Lower voltage indicates a poor ground. Attach negative voltmeter lead to ground. Voltage reading should not vary.

3) Contact negative lead to passenger's side bus bar. Probe each grid line at midpoint with positive lead. A 6-volt reading indicates line is good. A zero volt reading indicates a break between midpoint and driver's side bus bar line.

4) A 10-14 volt reading indicates a break between midpoint and passenger's side bus bar line. Move positive lead toward break and voltage will change when break is crossed.

NOTE: On some Jeep models feed wire and ground wires a reversed.

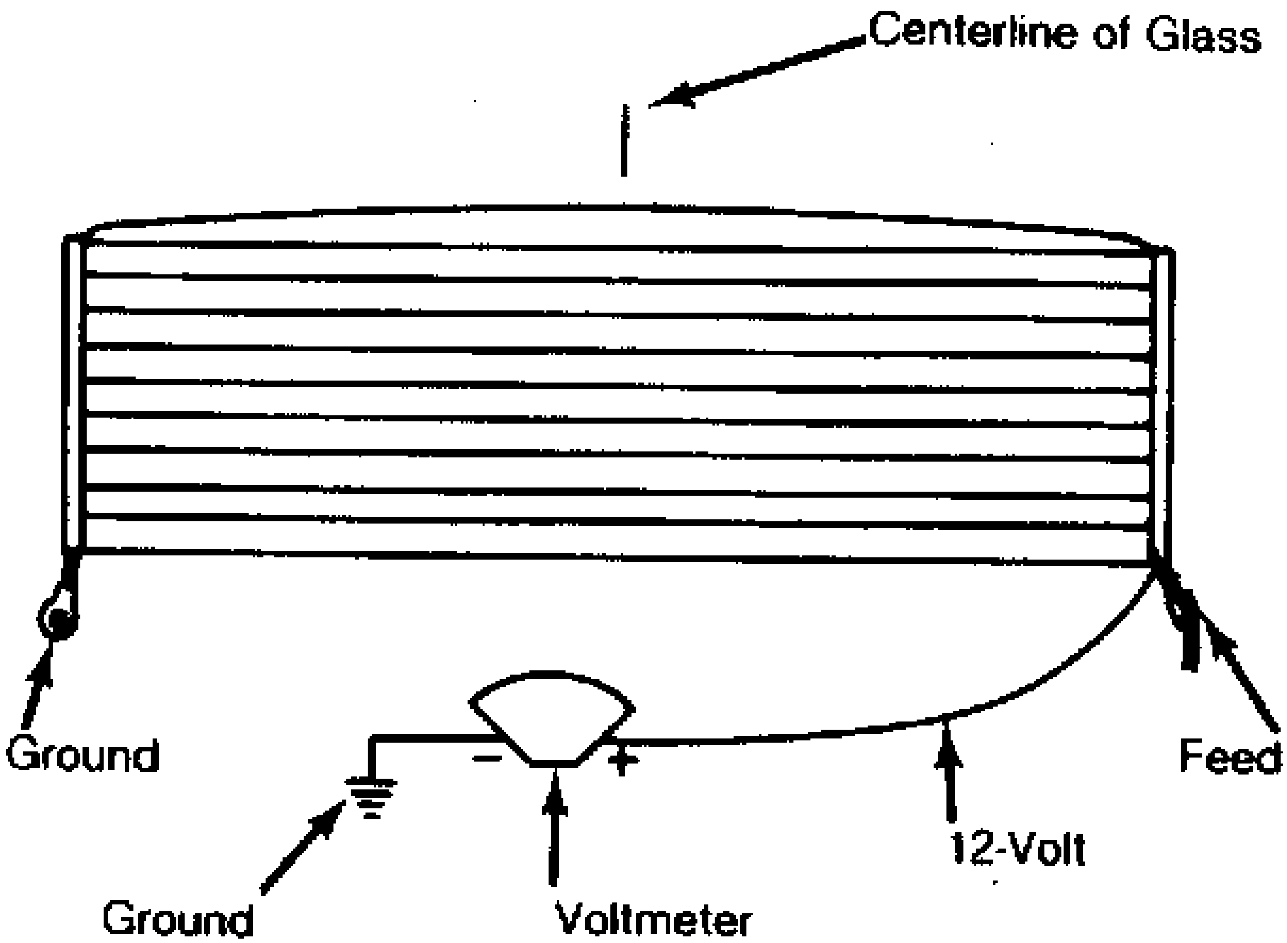


Fig. 2: Grid Continuity Voltage Drop

RELAY

NOTE: No relay testing is available for Wrangler models.

1) On Grand Wagoneer models, attach negative lead of voltmeter to ground. Probe Red wire at relay with voltmeter positive lead. Battery voltage should be indicated. If no voltage is indicated, operate tailgate window.

2) If window operates, wire between relay and window switch is open. Probe Orange wire at relay with voltmeter positive lead. No voltage should be indicated. Turn ignition switch to "ON" position. Voltmeter should indicate voltage. If not, relay is defective or not receiving voltage from Purple wire.

3) If relay operates properly, it should remain energized for 8 to 12 minutes before opening. If time period is too short or too long, relay is defective. If relay did not energize, connect a jumper wire to a 12-volt source in tailgate and probe Purple relay terminal.

4) If relay "clicks", trace Purple wire for open or short. If relay does not click, check relay ground. If ground is okay, relay should be replaced.

DIFFERENTIAL - DANA TRAC-LOK & POWER-LOK

1988 Jeep Cherokee

1988 Positive Traction Differentials - Dana Power-Lok & Trac-Lok

Jeep

DESCRIPTION

The limited slip differential uses 2 sets of multiple disc clutches to control differential action. Dana produces 2 types of positive traction differentials. The Power-Lok 4-pinion differential is a split-case type. The Trac-Loc 2-pinion differential is a single-case type.

OPERATION

When one or both wheels are on a low-traction surface such as snow, ice or mud, the friction between the clutch plates will transfer a portion of the usable torque to the wheel with the most traction. The wheel on ice or snow will have a tendency to operate with the opposite wheel in a combined driving effort.

AXLE RATIO & IDENTIFICATION

To determine axle ratio, see DRIVE AXLE RATIO IDENTIFICATION in this section.

LUBRICATION

NOTE: Always use special positive traction differential lubricant as specified by manufacturer.

DIAGNOSIS & TESTING

DANA 2-PINION TRAC-LOK

1) Drive vehicle to thoroughly warm up lubricant in rear axle. Place a piece of slick paper over a smooth formica board. Ensure formica board is on flat and level floor.

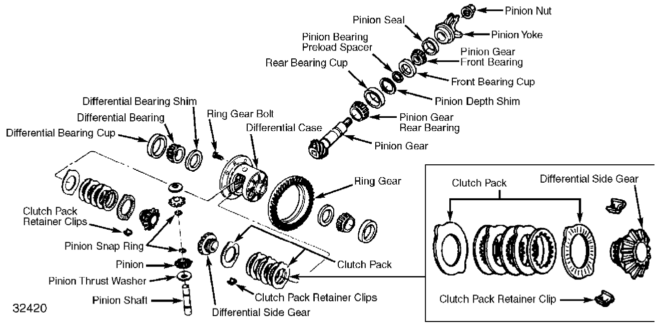


Fig. 1: Exploded View of Jeep Single-Case Dana Trac-Lok Differential

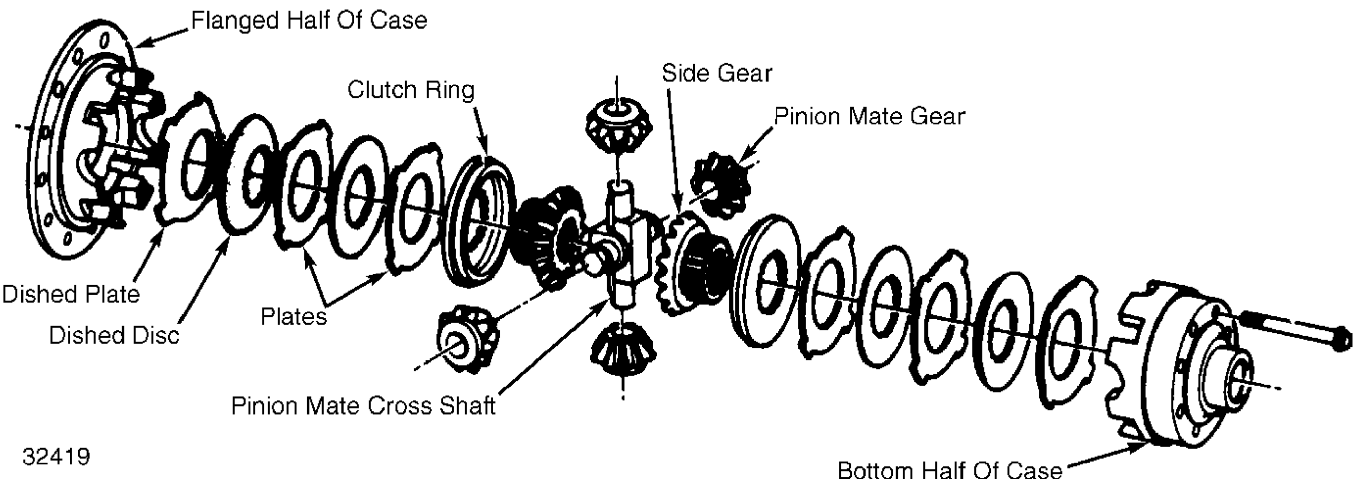


Fig. 2: Exploded View of Split Case (4-Pinion)

2) Drive vehicle over formica board until one rear wheel is in the center of board and paper. Place a block of wood 2" high and a minimum of 3" wide in front of one of the front wheels.

3) Open throttle gradually attempting to slowly drive vehicle over block of wood. If paper slips out of position, reposition paper and repeat test. If vehicle drives over block of wood, axle is functioning properly.

DANA 4-PINION POWER-LOK

1) With engine off and transmission in "N", raise one wheel off ground. Block both front and rear wheels of opposite side. Install adapter tool across 2 wheel studs and attach torque wrench to center of tool.

2) Observe torque required to continuously turn wheel smoothly through several revolutions. Repeat test for opposite side. If differential is okay, torque should be 40-200 ft. lbs. (54-272 N. m). Disregard breakaway torque. Use rotating torque only.

NOTE: Exploded view of Chrysler Motors Trac-Lok differential was not available from manufacturer.

REMOVAL & INSTALLATION

See DANA SEMI-FLOATING or FULL-FLOATING AXLE article in this section.

OVERHAUL

DANA 2-PINION TRAC-LOK

NOTE: For front axle shaft and bearing removal, see articles on DANA FULL-FLOATING AXLES or 4WD STEERING KNUCKLES in this section. With the exception of ring gear and differential side bearings, Chrysler Motors does not recommend disassembly of differential. If repair is required, manufacturer recommends replacing entire unit as an assembly.

Disassembly (Jeep)

1) Using 2 screwdrivers, remove pinion snap rings. Using a brass drift and a hammer, remove pinion shaft from case. Install Step

Plate (J 23781-7) in bottom side gear. Install grease in centering hole of step plate. Position Rotating Tool (J 23781-3) on step plate tool. Coat threads of Forcing Screw (J 8646-2) with oil.

2) Insert forcing Screw (J 8646-2) through case and thread into rotating tool. Thread screw through tool until it contacts centering hole in step plate. Tighten forcing screw to relieve clutch pack tension from pinions. Remove pinion thrust washers.

3) Tighten forcing screw until all clutch pack tension is relieved from pinions. Slide rotating tool pawl so it engages with side gear teeth. Rotate side gears with rotating tool until pinions can be removed through case opening.

4) Remove forcing screw, rotating tool, upper side gear and clutch pack. Remove differential case from axle shaft. Remove remaining side gear, clutch pack and step plate tool. Remove retainer clips from clutch packs. Mark clutch packs for reassembly reference. Using a press, remove differential bearings.

Cleaning & Inspection

Clean all parts and dry with compressed air. If any clutch plates or discs require replacement, all plates and discs should be replaced. Replace any worn or damaged components.

NOTE: For adjustment procedures, see DANA SEMI-FLOATING or FULL FLOATING AXLE articles in this section

Reassembly

1) Lightly lubricate clutch pack discs with axle lubricant. Assemble clutch pack discs and install retaining clips on ears of discs. See Fig. 3. Install assembled clutch packs on side gears.

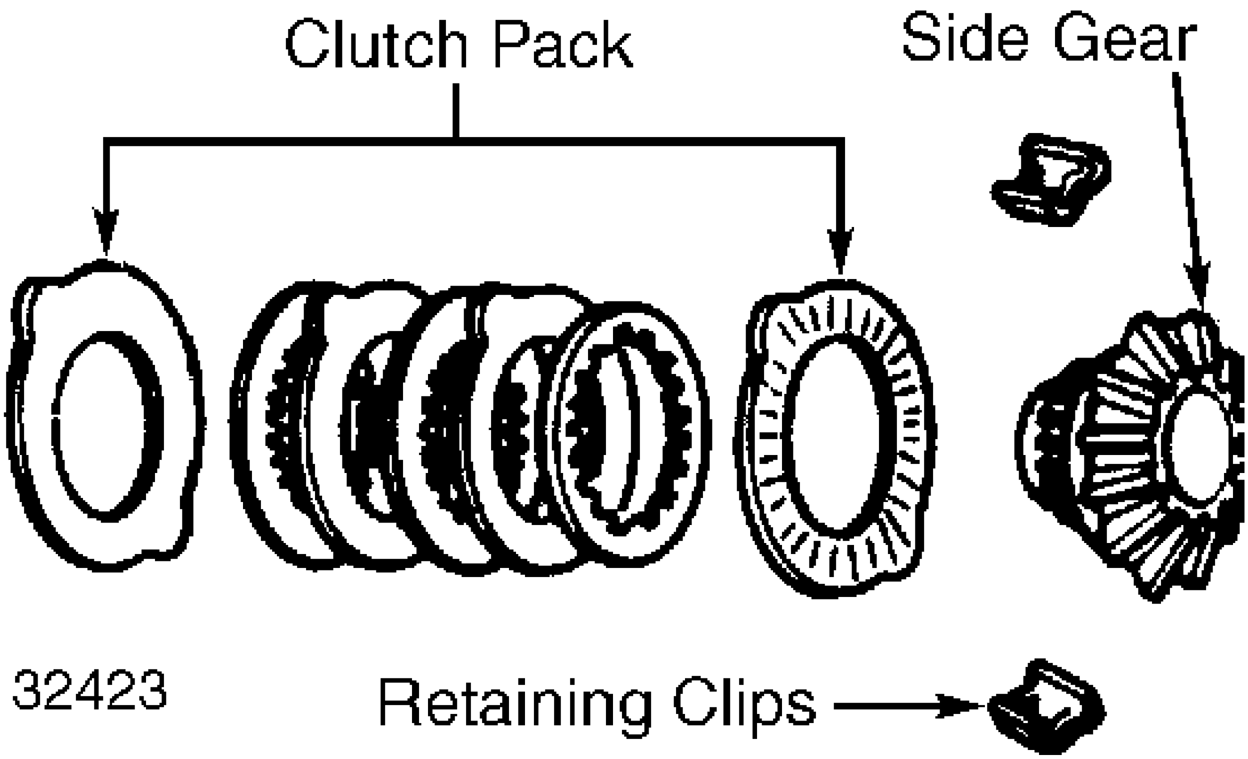


Fig. 3: Typical Clutch Pack Assembly

2) Mount differential case on axle shaft. Install first clutch pack and side gear in bottom bore of case. Ensure retaining clips remain seated in case pockets. Install Step Plate (J 8646-2) in

clutch pack just installed.

3) Install remaining side gear and clutch pack in case. Hold assembly in position and install rotating tool and forcing screw. Tighten forcing screw and compress clutch packs. Install pinions. Rotate side gear with tool pawl until each pinion is aligned with pinion shaft bore.

4) Install pinion thrust washers and pinion shaft. Install pinion thrust washers and pinion shaft. Install snap rings on pinion shaft. Remove differential from axle shaft. Remove shaft from vise. Using Remover (J 22912-01), remove differential bearings. Install end play shims on each side of case. Reinstall differential bearings.

5) Position ring gear on differential case. Install NEW ring gear bolts and tighten to 52 ft. lbs. (70 N.m).

DANA 4-PINION POWER-LOK

NOTE: Differential bearings do not need to be removed to overhaul.

Disassembly

1) Mark case halves, pinion mate shafts and ramps for reassembly reference. Clamp differential assembly in soft-jawed vise and loosen case half bolts (DO NOT remove bolts). Position differential assembly on bench with ring half of case down. Remove case attaching bolts. Remove cover half of case.

2) Remove pinion mate gear, side gear ring and clutch pack. Keep parts together for reassembly reference. Remove parts from drive gear half of case.

Cleaning & Inspection

Clean all parts and dry with compressed air. If any clutch plates or discs require replacement, it is recommended that all plates and discs be replaced. Replace any part that is worn or damaged.

Reassembly

NOTE: For adjustment procedures, see DANA SEMI-FLOATING or FULL FLOATING AXLE articles in this section.

1) Position side gear ring from drive gear half of case on a pinion flange. Coat clutch plates with Hypoid Gear Lubricant (C6A-Z-19580-E). Reassemble parts in correct order. See Fig. 1. Install ring gear half of case over clutch pack and side gear ring. Ensure clutch plate lugs enter slots in case and case bottoms on clutch pack.

2) Hold assembly together and turn case half upside down. Install gear in side gear ring. Install mate shaft and pinions on side gear ring. Align mate shaft and case markings. Install cover half mate shaft and pinions. Align markings.

3) Install side gear on pinions. Position side gear ring on side gear and pinions. Assemble clutch pack on side gear. See Fig. 4. Align clutch plate lugs and install all parts in case. Position cover half of case over assembly. Align case marks made during disassembly.

4) Lubricate bolt threads with axle lube and install case bolts. Using both axle shafts, align splines of side gear and side gear ring. Tighten case bolts to 65-70 ft. lbs. (89-94 N.m).

5) Remove axle shafts. If properly assembled, each pinion mate cross shaft should be tight on its ramp. If clearance is present, it should not exceed .010" (.254 mm).

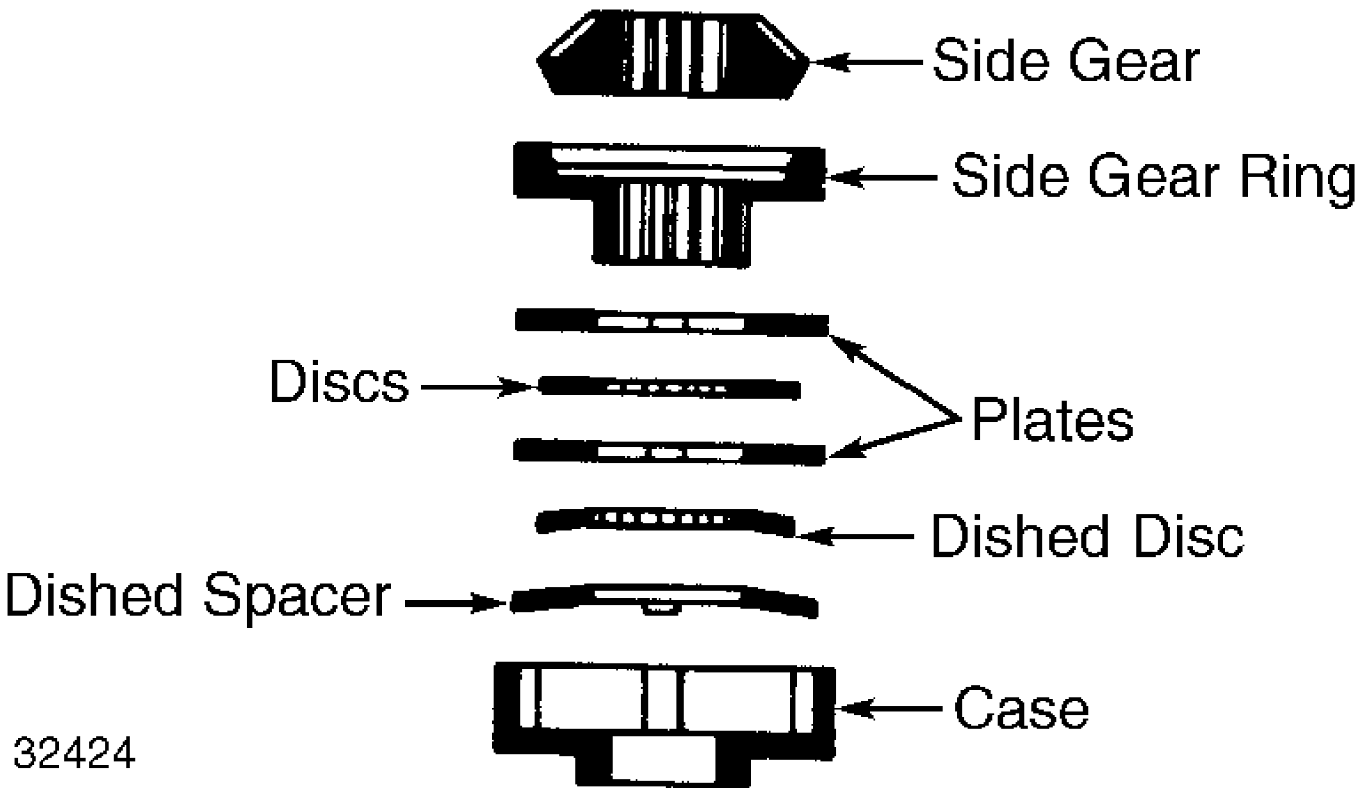


Fig. 4: Power-Lok Differential Clutch Pack Assembly
Courtesy of Ford Motor Co.

1988 Power Door Locks
JEEP

DESCRIPTION

Jeep vehicles with power door locks use a motor-actuated lock system, controlled by rocker switches. Operation of switch assembly controls the actuator motor.

Power door locks are protected by a 30-amp circuit breaker located in the fuse block. Power door locks will not operate from outside the vehicle.

TESTING

SWITCH

Using ohmmeter, test switches for continuity. Connect ohmmeter across terminals as shown. See Fig. 1. Continuity should exist between terminals in all positions.

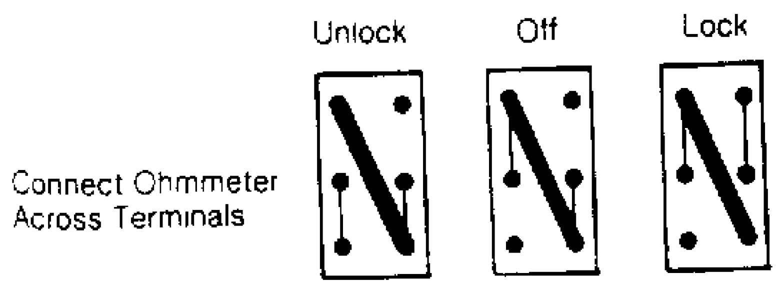


Fig. 1: Checking Switch Continuity
Courtesy of Chrysler Motors.

ACTUATOR MOTOR

Connect ammeter to actuator motor terminals. Operate door switch and note reading. Current draw should not exceed 8 amps at room temperature. Actuator should complete full travel within one second. Replace actuator motor if not within specification.

CIRCUIT BREAKER

1) Disconnect harness connector from fuse block. Using test light, check fuse block harness connection for voltage. If there is no battery voltage at connection, check for burnt fusible link in engine compartment.

2) Check circuit breaker continuity if voltage exists. Using ohmmeter, test circuit breaker for continuity. Replace circuit breaker if no continuity exists.

3) If circuit breaker tests okay, check for battery voltage at circuit breaker connection of fuse block with wiring harness installed. If voltage exists at wiring harness but not at circuit breaker connection, check fuse block for damage.

REMOVAL & INSTALLATION

DOOR LOCK SWITCH

Disconnect battery negative cable. Remove door trim panel. Remove switch housing from inner door panel. Pry wiring retaining clips upward while disconnecting wiring. Depress retainer clips through holes in switch housing. Remove switch assembly. To install, reverse removal procedure.

ACTUATOR MOTOR

1) Disconnect battery negative cable. Remove door trim panel. Drill out actuator motor retaining rivets using a 1/4" drill bit.

2) Disconnect actuator rod from bellcrank. Disconnect wires from actuator motor, and remove motor. To install, reverse removal procedure, using new rivets.

DRIVE AXLE - FULL FLOATING

1988 Jeep Cherokee

Drive Axles - Dana Full-Floating Axles

Jeep Front & Rear Drive Axles

DESCRIPTION

The axle assembly is an integral carrier type with hypoid gear ring and pinion. Stamped steel cover is removable for inspection and repair of differential. Vehicle loads are carried by axle housings. Axle shafts of "full-floating" rear assemblies may be removed without disturbing wheel bearings.

Drive pinion depth, pinion bearing preload and differential side bearing preload are all set by shims.

See LOCKING HUB and 4WD STEERING KNUCKLE articles in this section for removal and installation procedures for these front drive axle component parts.

AXLE RATIO & IDENTIFICATION

A metal tag on axle is stamped with gear ratio, part numbers and limited slip identification. To determine drive axle ratio, refer to MODEL IDENTIFICATION BY RING GEAR SIZE table.

MODEL IDENTIFICATION BY RING GEAR SIZE

Model	Ring Gear Diameter
44	8.50"
60	9.75"
61	9.75"
70	10.50"
80	11.25"

FRONT HUB, BEARING, SPINDLE & AXLE SHAFT R & I

FRONT HUB BEARING ADJUSTING SPECIFICATIONS

Application	(1) Ft. Lbs. (N.m)
Adjusting Nut	
Step 1	50 (68)
Step 2	Back Off 20°
Lock Nut	50 (68)

(1) - While Rotating Hub.

REMOVAL (CHEROKEE, COMANCHE & WAGONEER)

1) Raise and support vehicle. Remove tire and wheel assembly. Remove disc brake caliper and support out of way.

2) Match mark disc rotor and hub and remove disc rotor. Remove cotter pin, nut lock and axle hub nut. Remove hub-to-knuckle bolts. Pull hub assembly off axle shaft. Pull axle shaft through knuckle to remove. Inspect axle shaft "U" joint and shaft splines for wear. Replace as necessary.

3) Press hub out of bearings. Remove seals and bearings.

Inspect bearings and races for wear and pitting. Replace bearing and race together.

INSTALLATION

1) Install axle shaft through knuckle and engage in axle gear splines. Pack bearings with multi-purpose grease and fill cavities in bearing hub. Install new seals.

2) Press hub into bearings. Install hub assembly on axle shaft and install bolts. To complete installation, reverse removal procedure. See TORQUE SPECIFICATIONS table at end of this article.

INTERMEDIATE AXLE SHAFT R & I

REMOVAL (DISCONNECT AXLE MODELS)

1) Remove outer axle. See FRONT HUB, BEARING, SPINDLE & AXLE SHAFT in this article.

2) Remove axle assembly inspection cover and drain fluid. Remove vacuum and electrical connections at disconnect housing assembly. Remove bolts and pull disconnect housing from axle tube. See Fig. 1.

3) Remove intermediate shaft retaining clip on inner end of axle shaft. Carefully slide intermediate axle shaft through seal and out end of axle tube. Remove shift collar.

4) Inspect intermediate shaft bearings and seals for wear. If replacement of bearings or seal is necessary, use recommended tools.

5) On Jeep, use Tool Set (J-34659), Slide Adapter (J-34659-4) and Over Rod (J-34659-3) to replace intermediate shaft bearings and seal.

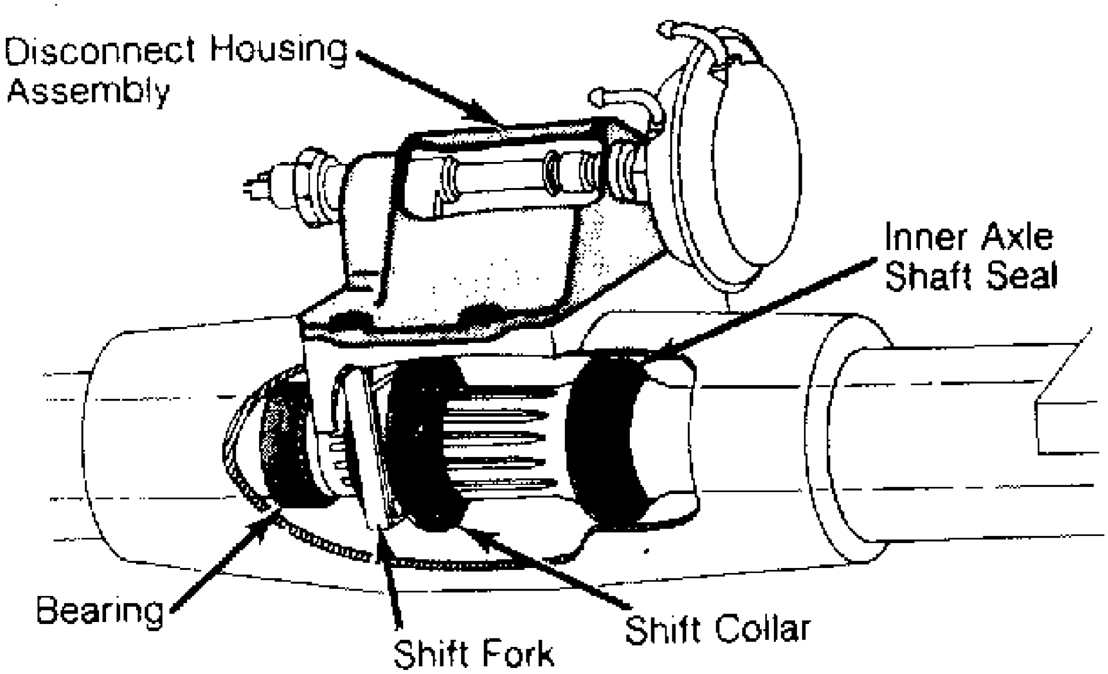


Fig. 1: View Of Axle Disconnect Assembly
Courtesy of Chrysler Motors.

INSTALLATION

1) Coat intermediate shaft with lubricant and carefully slide through seal and engage in drive axle splines. Install retaining clip.

2) Install shift collar on axle shaft. Install outer axle shaft and check for smooth operation of shift collar.

3) Apply bead of silicone sealer to inspection cover and install cover. Fill axle housing with 2.5 pts. (1.2L) of 75W 90 gear oil. Pour a small amount of gear oil on shift collar and install disconnect housing. Ensure shifting fork is properly positioned in shift collar.

4) To complete installation, reverse removal procedure. Tighten all bolts and nuts to specification. See TORQUE SPECIFICATIONS table at end of this article.

FRONT AXLE ASSEMBLY R & I

REMOVAL (CHEROKEE, COMANCHE, WAGONEER)

1) Raise and support vehicle. Remove tire and wheel assembly. Remove hubs, spindles and axles. See FRONT HUB, BEARING, SPINDLE & AXLE SHAFT in this article.

2) Disconnect vacuum hoses and electrical connections from shift motor. Disconnect stabilizer bar, track bar and steering damper.

3) Disconnect drive shaft at pinion yoke and tie to frame. Remove left and right tie rod ends from knuckles.

4) Support axle assembly on floor jack. Remove lower shock mounts. Disconnect axle housing-to-frame control arms at axle. Lower floor jack slowly and remove axle assembly. Remove coil spring lower bracket and coil spring.

INSTALLATION

1) Place axle housing on floor jack and position under vehicle. Install coil springs and raise assembly into position. Ensure top of coil springs seat in spring pocket.

2) Check all bushings and mounting hardware for wear or damage. To complete installation, reverse removal procedure. Tighten all bolts and nuts to specification. See TORQUE SPECIFICATIONS table at end of this article. Fill axle assembly with gear oil. Check wheel alignment.

REAR HUB, BEARINGS & AXLE SHAFTS R & I

1) Raise and support vehicle. Remove tire and wheel assembly. Remove axle flange nuts or bolts. If nuts are used, rap center of axle flange sharply with hammer to loosen tapered dowels. Remove bolts or dowels and pull axle shaft out of hub.

2) Depending on application, bend back ears of lock washer, or remove locking wedge from nut, or remove snap ring and key. Remove bearing adjusting nut(s) and remove hub assembly.

3) Remove inner hub seal and bearing. Inspect bearings and races for wear. To replace bearing, drive outer race from bearing hub using a punch and hammer. Install new race being careful not to chip or dent race. Ensure new race is seated in hub.

4) Pack bearings with multi-purpose grease. Install new seal. Carefully install hub on axle spindle to avoid damaging seal lip and spindle threads.

5) Install outer bearing and adjusting nut. Tighten bearing adjusting nut in steps. See REAR HUB BEARING ADJUSTING SPECIFICATIONS table. Install lock ring if used. Install spindle lock nut if used and tighten to proper specification. See REAR HUB BEARING ADJUSTING SPECIFICATIONS table.

REAR HUB BEARING ADJUSTING SPECIFICATIONS

Application	(1) Ft. Lbs. (N.m)
Adjusting Nut	
Step 1	50 (68)
Step 2	Back Off 45°
Lock Nut	50 (68)

(1) - While rotating hub.

6) Install new axle flange gasket or apply silicone sealer. Install axle and tighten bolts or nuts to proper specification. See TORQUE SPECIFICATIONS table at end of this article.

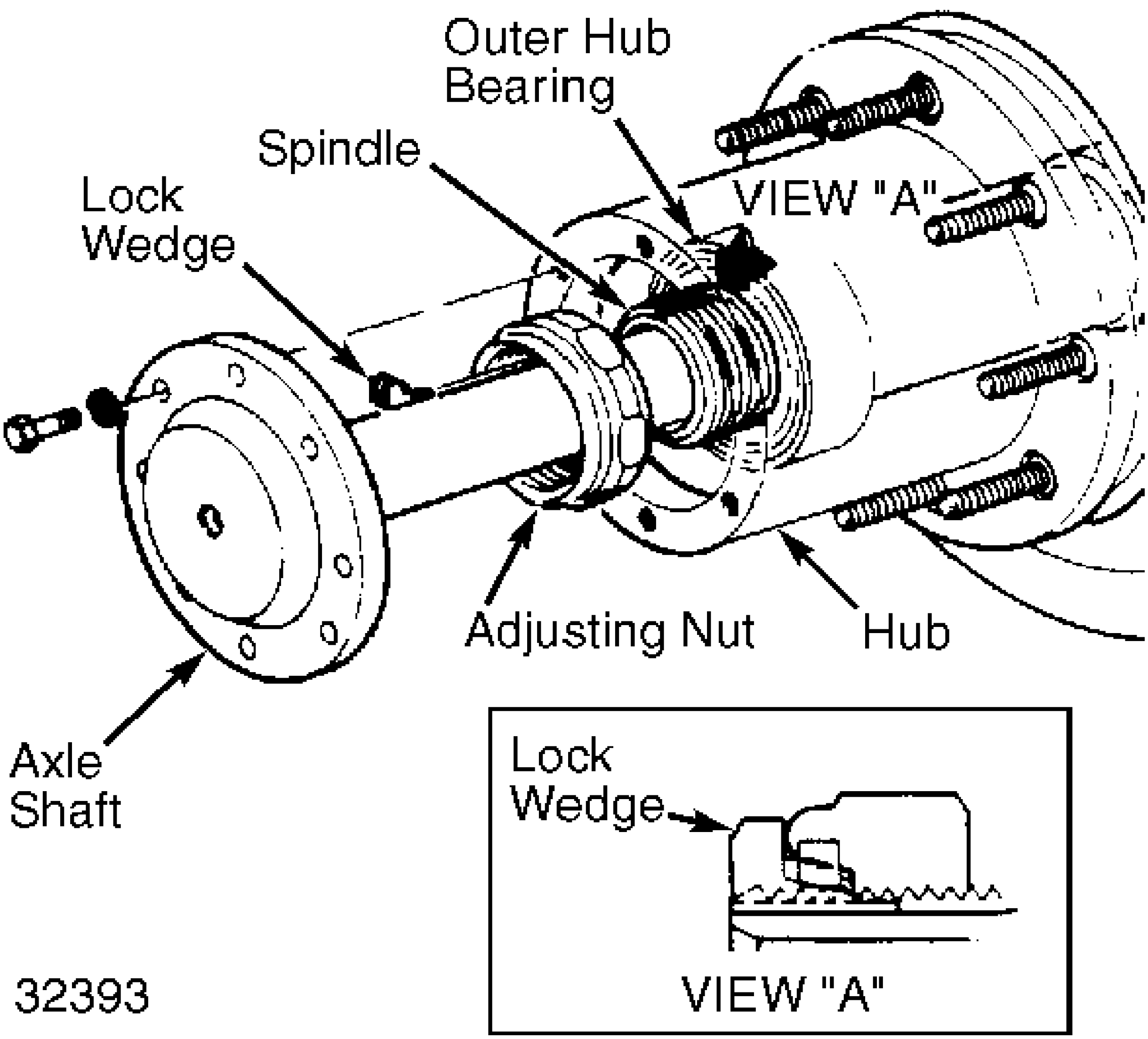


Fig. 2: Rear Hub & Bearing Adjuster

REAR AXLE ASSEMBLY R & I

REMOVAL

1) Raise and support vehicle. Remove wheels, hubs and axles. See REAR HUB, BEARINGS AND AXLE SHAFTS.

2) Remove lower shock mounts and stabilizer bar mount. Disconnect drive shaft and tie up. Remove hydraulic brake line at junction and plug.

3) Disconnect park brake cables and hydraulic brake lines to wheel cylinders or calipers. Remove brake backing plate or caliper.

4) Support axle housing with floor jack and remove leaf spring "U" bolts. Carefully lower axle housing and remove from vehicle.

INSTALLATION

Place axle housing on floor jack. Raise axle and install "U" bolts and nuts. To complete installation, reverse removal procedure. Tighten all bolts and nuts to specification. See TORQUE SPECIFICATIONS table at the end of this article and REAR HUB BEARING ADJUSTING SPECIFICATIONS table.

PINION SEAL & YOKE R & I

REMOVAL

1) Raise and support vehicle. Mark drive shaft-to-yoke contact area for reassembly reference. Remove drive shaft-to-yoke attaching nuts/strap bolts. Discard used strap bolts. Remove drive shaft.

2) Using a breaker bar and Pinion Nut Remover (8614-01), remove pinion nut and washer. See Fig. 3. Using Yoke Pullers (8614-01), (8614-02) and (8614-03), remove yoke. See Fig. 4. Using Pinion Seal Remover (J-9233 or J-7583), remove pinion seal from front differential housing. See Fig. 5.

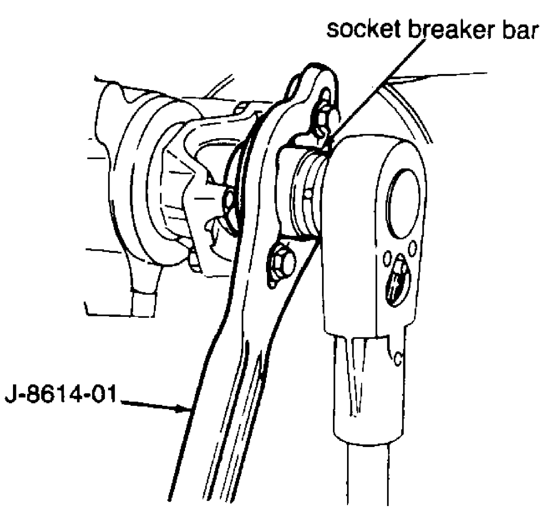


Fig. 3: Removing Pinion Nut & Washer

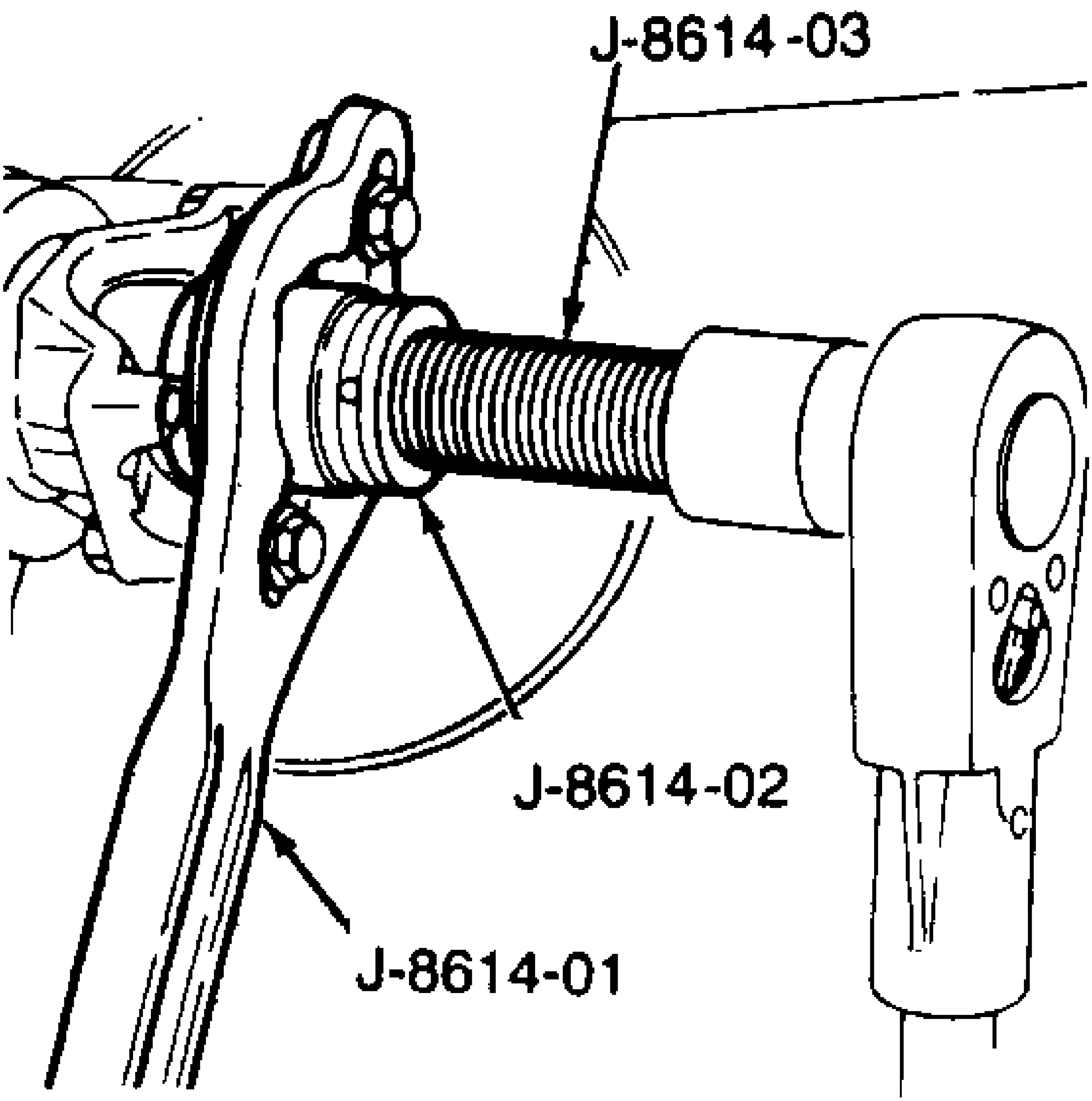


Fig. 4: Removing Front Drive Axle Yoke

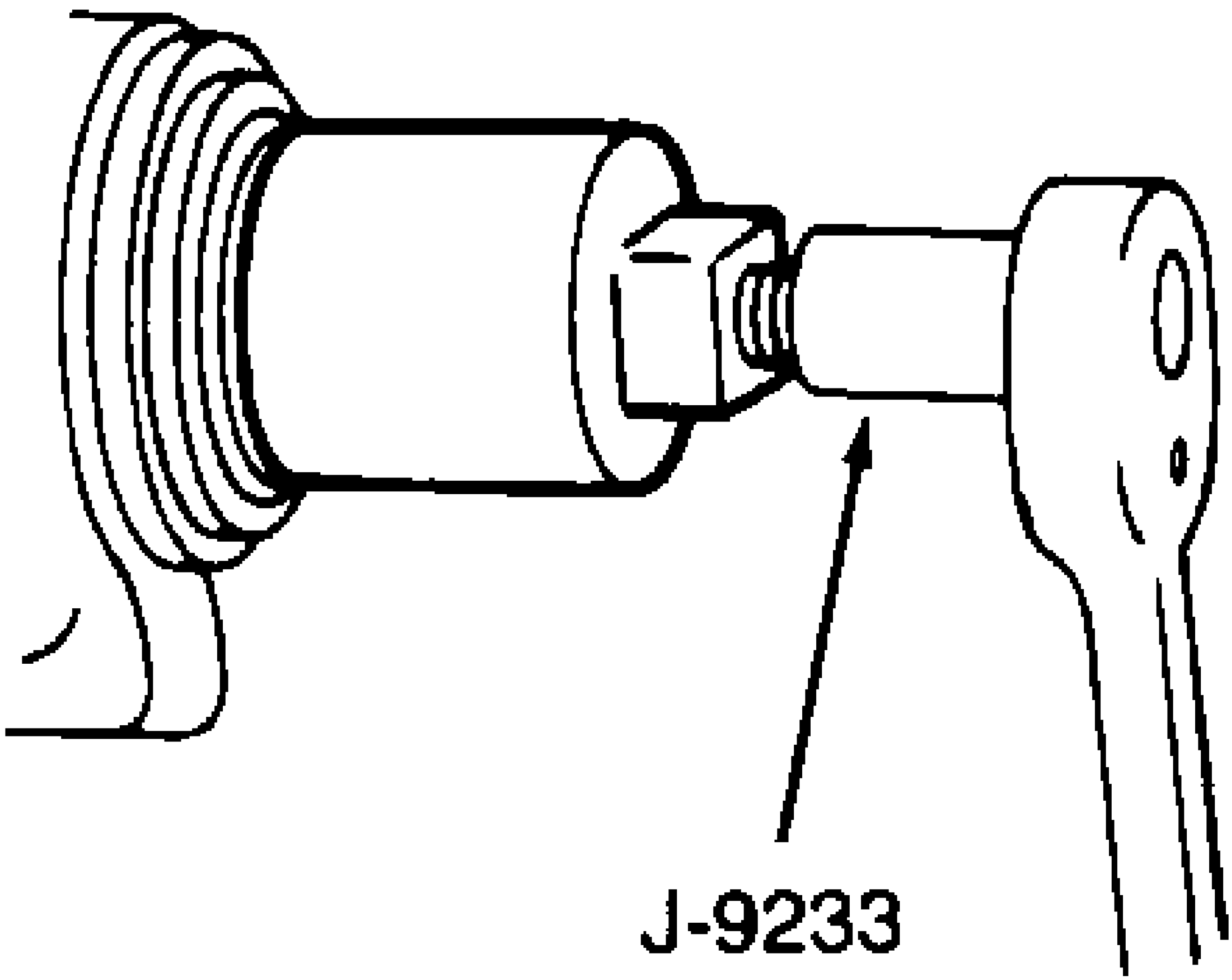


Fig. 5: Removing Pinion Seal

INSTALLATION

Using Seal Installer (J22661), drive new seal into front differential housing. See Fig. 6. Tighten yoke attaching nut to 210 ft. lbs. (285 N.m). Using NEW strap bolts, align and install drive shaft. Tighten strap bolts to 14 ft. lbs. (19 N.m). Fill differential with SAE 75W-90 gear lubricant.

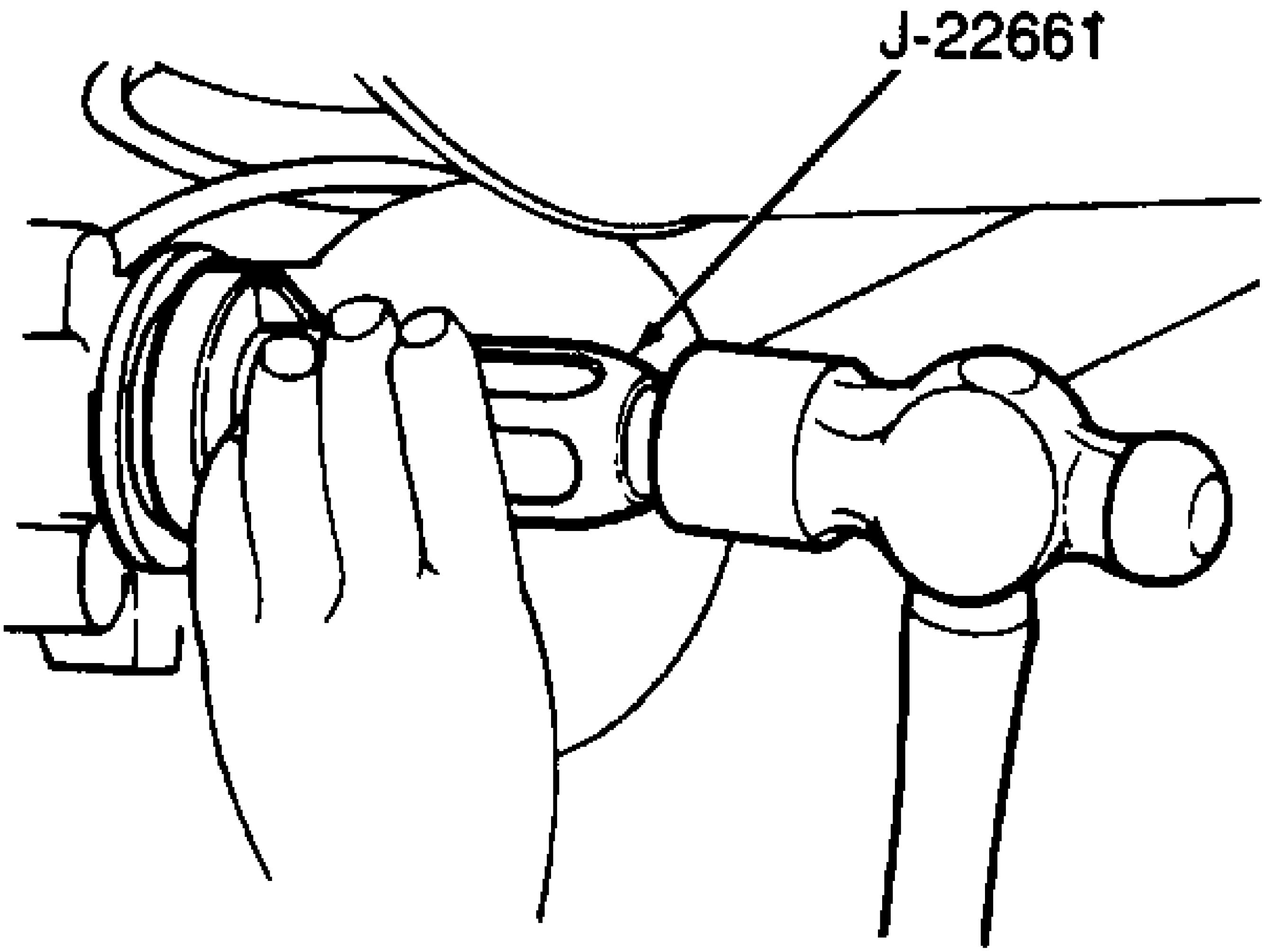


Fig. 6: Installing New Front Axle Shaft Seal

AXLE SHAFT OVERHAUL

NOTE: All front axle shafts except (Select-Trac) use Cardan "U" joints and should be overhauled in same manner as drive shaft "U" joints.

DISASSEMBLY (SELECT-TRAC)

1) Cut and remove both outer boot clamps. Slide boot off outer CV joint.

2) Using a block of wood seated on inner race, tap joint from shaft. If shaft is clamped in a vise, be sure to use protective vise jaws.

3) Tap outer CV cage with a brass punch until cage is tilted

out far enough to remove first ball bearing. Remove remaining ball bearings in same manner.

4) Rotate outer CV joint cage outward until it is at a 90 degree angle to installed position. Align 2 oblong holes in outer joint cage with slots in interior wall of spindle housing and remove cage and inner race.

5) Remove inner race from cage by aligning shoulder between race grooves with inside of oblong cage holes. Rotate inner race out of cage using larger of 2 openings in cage. Remove retaining ring, spacer ring and outer boot.

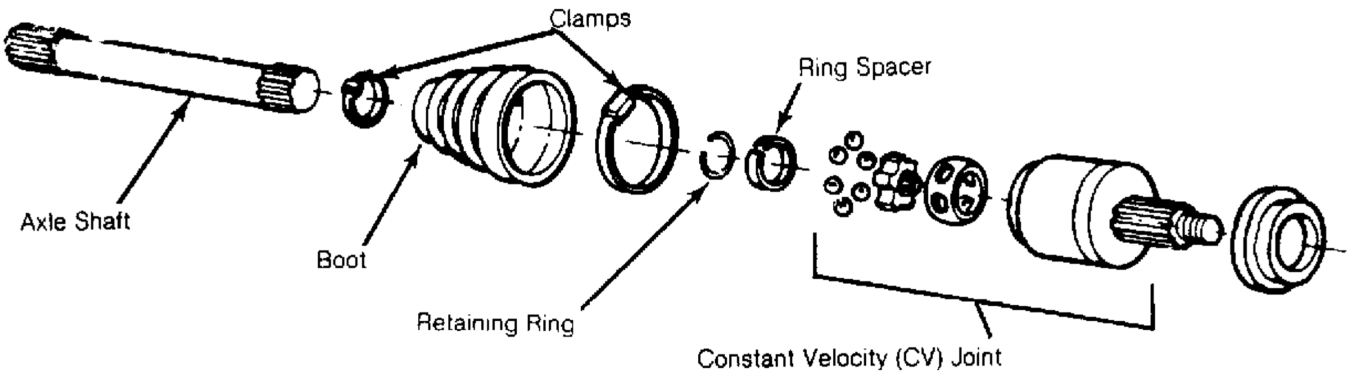


Fig. 7: Exploded View of Jeep (Select-Trac) Drive Axle
Courtesy of Chrysler Motors.

CLEANING & INSPECTION

1) Wash all parts in solvent and dry. Inspect inner and outer ball races for damage. Inspect splined stub shaft for wear, cracks and twisted splines.

2) Inspect all 6 balls for pitting, cracking or scoring. Dulling of surface is normal. If any damage is found, replace entire CV joint assembly. Polished areas in races and on cage spheres are normal and DO NOT require joint replacement.

REASSEMBLY

1) Apply a light coat of CV grease on ball grooves of inner and outer races. Install inner race into cage using a rotating action opposite of removal. Inner race snap ring should face axle side.

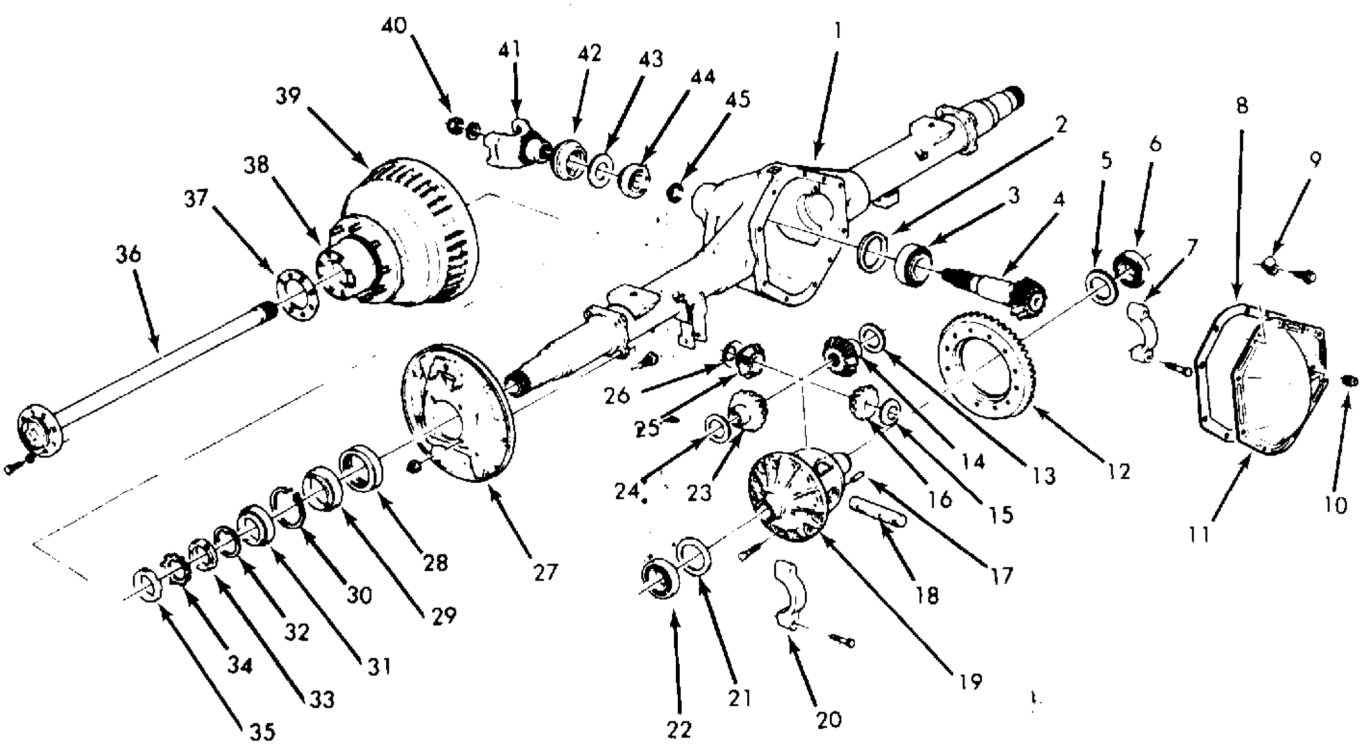
2) Be sure ball bearing retaining ring is installed on inner race side facing small end of cage. Align windows of cage with outer race lands, and pivot cage with inner race into tilted position (opposite of removal).

3) Install ball bearings one at a time into outer CV joint as cage is tilted and rotated. After balls are installed into cage, pivot cage and inner race into installed position.

4) Slide new seal clamp for small end of boot seal, boot seal and seal retainer onto axle shaft. Coat inside lip (large diameter end of seal) with CV grease. Slide seal retainer on end of seal.

5) Spread ears of bearing race snap ring, and slide CV joint onto axle shaft until snap ring seats in groove. Pack joint with approximately 1/2 of grease provided in seal kit. Apply remaining grease inside seal.

6) Slide seal toward joint until small end of seal is in groove in axle shaft. Position small clamp over small end of seal and into groove and tighten.



1. Carrier Housing
2. Shim Pack
3. Inner Pinion Bearing
4. Drive Pinion
5. Shim Pack
6. Side Bearing
7. Bearing Cap
8. Cover Gasket
9. Clip
10. Plug
11. Cover
12. Ring Gear
13. Thrust Washer
14. Side Gear
15. Thrust Washer
16. Pinion Gear
17. Lock Pin
18. Pinion Shaft
19. Differential Case
20. Bearing Cap
21. Shim Pack
22. Side Bearing
23. Side Gear
24. Thrust Washer
25. Pinion Gear
26. Thrust Washer
27. Backing Plate
28. Seal
29. Inner Hub Bearing
30. Snap Ring
31. Outer Hub Bearing
32. Adjusting Washer
33. Adjusting Nut
34. Lock Washer
35. Lock Nut
36. Axle Shaft
37. Axle Flange Gasket
38. Hub
39. Brake Drum
40. Flange Nut
41. Pinion Flange
42. Pinion Seal
43. Slinger
44. Outer Pinion Bearing
45. Shim Pack

Fig. 8: Exploded View Of Dana Full-Floating Axle Assembly

AXLE ASSEMBLY OVERHAUL

DISASSEMBLY

1) Drain lubricant. Remove axle shafts and housing cover. If no side play is found in the differential case assembly, mount dial indicator on pilot stud with tip against back of ring gear. Measure runout of ring gear, marking ring gear and case at point of maximum runout.

2) If runout total exceeds .006" (.15 mm), ring gear could be loose or case could be damaged. Using .003" (.08 mm) feeler gauge, try to force feeler gauge between cap and race. If it does, bearing race may have been turning in carrier.

3) If race has been turning, carrier could be damaged. Observe identifying letters stamped into bearing caps and face of carrier sealing surface. Use these matched letters for reassembly reference.

4) Remove side bearing caps. Use Housing Spreader (W-129-A on

Model 44; D-167 on Models 60, 61, 70 and 80) to spread differential housing to .015" (.38 mm). See Fig. 9.

CAUTION: DO NOT spread housing more than .020" (.51 mm). Permanent damage to housing could result.

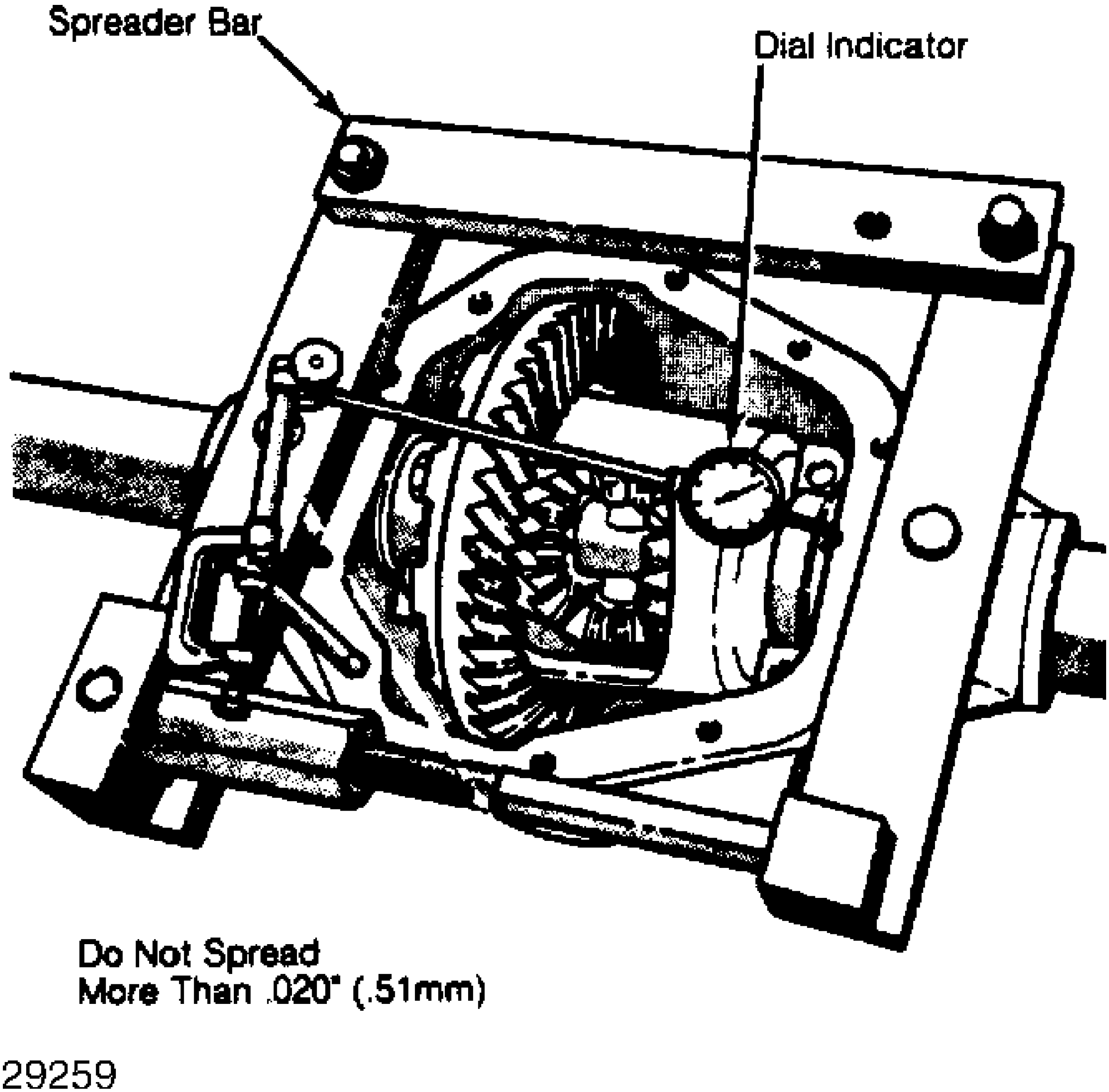


Fig. 9: Correct Procedure for Spreading Housing

5) Pry differential case out of housing. Remove spreader to prevent carrier taking set. On models with side bearing shims between carrier and side bearing outer race, record sizes and positions of shims. Be careful not to damage machined surfaces of housing.

6) Put case in soft-jawed vise and remove ring gear bolts and

discard. Tap ring gear loose with soft mallet. If ring gear runout measured earlier exceeded .006" (.15 mm), repeat runout measurement of case without ring gear. Total runout of case should not exceed .003" (.08 mm).

7) Using Flange Holder Wrench (C-3281), remove drive pinion nut and washer. Using holder wrench and Flange Puller (C-452), remove drive pinion flange. Using Pinion Seal Puller (C0748), remove pinion oil seal. Remove slinger, gasket, outer pinion bearing and preload shim pack.

8) Remove drive pinion with inner bearing. Remove inner and outer pinion bearing races. Remove and note thickness of shim pack behind inner bearing race. Remove inner pinion bearing from pinion shaft using Puller Press (DD-914-P) with Adapter Ring (DD-914-9) and Pinion Bearing Puller Plates (C-293-39 on Model 44; DD-914-37 on Model 60 and 61; DD-914-95 on Models 70 and 80).

NOTE: Pinion bearing adjusting shims may remain on pinion shaft, stick to bearing or fall loose. Collect and save them for reassembly.

9) Remove side bearings with Bearing Puller (C-293-PA), Extension Plug (C-293-3 on Model 44; DD-914-7 on Models 60, 61, 70 and 80) and Puller Plates (C-293-18 on Model 44; DD-914-62 on Models 60, 61, 70 and 80). Record shim thickness and location for reassembly reference.

10) If differential case is a one-piece unit, drive out lock pin holding differential pinion shaft to case. Remove differential pinion shaft, gears and thrust washers (one for each gear).

11) If differential case is a 2-piece unit, mark both differential case halves to aid reassembly in correct position. Remove bolts holding case halves together. Tap on top half of case to break it loose from lower half. Remove top half of case. Remove pinion gear spider, pinion gears, side gears and all thrust washers.

INSPECTION

1) Use cleaning solvent to rinse gears and bearings. Check large end of bearing rollers where wear, if any, is evident. Check pinion and flange splines for excessive wear. Ensure ring gear teeth are in good condition.

2) Check differential case for cracks, scoring of side gears, thrust washers and pinion thrust faces. Check fit of side gears to case and to axle shaft splines. Look at pinion shaft and spacer for scoring or excessive wear.

REASSEMBLY & ADJUSTMENTS

1) When reassembling and adjusting ring and pinion assembly, pinion depth, pinion bearing preload, side bearing preload and backlash between ring and pinion must be adjusted.

2) If only pinion shaft and ring gear are to be replaced and carrier housing can be reused, compare pinion depth adjustment numbers etched in faces of old and new pinion heads. See Fig. 10. Using PINION DEPTH SHIM ADJUSTMENT SPECS table, correct shims can be selected for new pinion shaft depth adjustment.

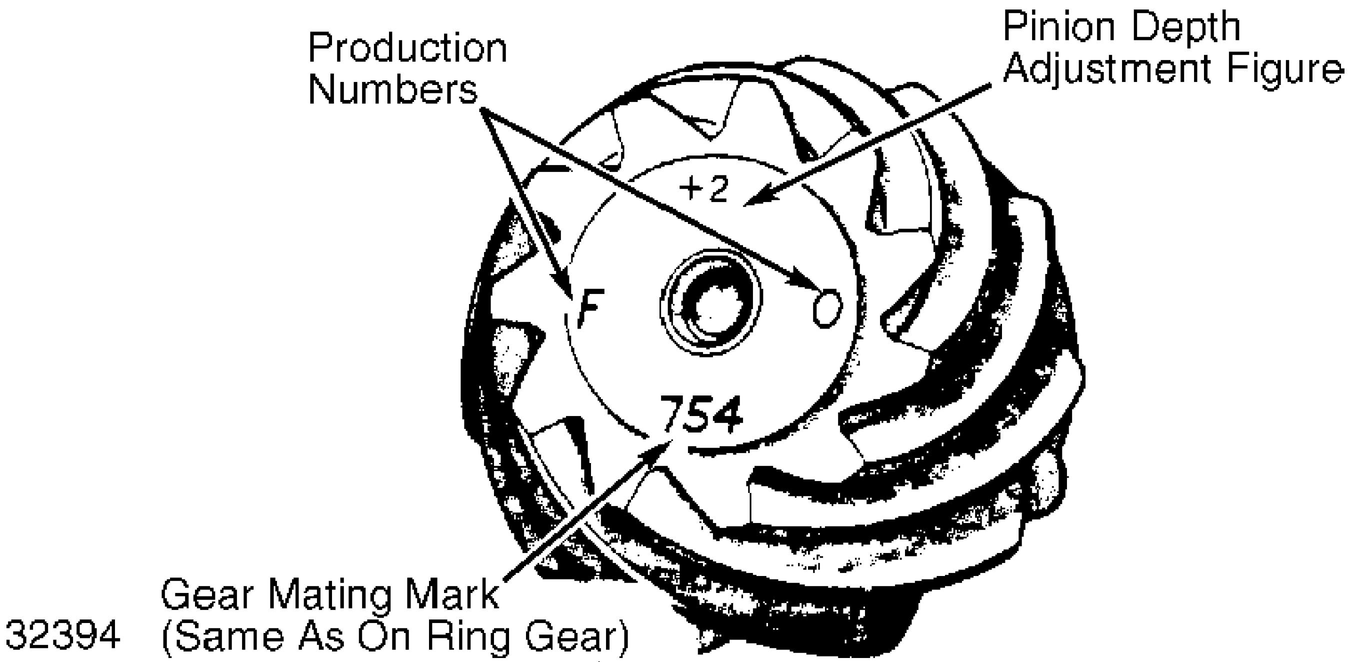


Fig. 10: Location of Pinion Gear Markings W/ Depth Adjustment Figures

NOTE: In order to use PINION DEPTH SHIM ADJUSTMENT SPECS table, old pinion shaft shim pack dimensions MUST be determined accurately. If original pinion shaft shim pack dimension cannot be determined accurately, Pinion Depth Gauge Set (D-271) must be used to properly determine pinion depth setting. Depth gauge set must also be used if new carrier housing is to be used.

PINION DEPTH SHIM ADJUSTMENT SPECS

PINION DEPTH SHIM ADJUSTMENT CHART (INCHES)

Old Pinion Marking	New Pinion Marking								
	-4	-3	-2	-1	0	+1	+2	+3	+4
+4	+0.008	+0.007	+0.006	+0.005	+0.004	+0.003	+0.002	+0.001	0
+3	+0.007	+0.006	+0.005	+0.004	+0.003	+0.002	+0.001	0	-0.001
+2	+0.006	+0.005	+0.004	+0.003	+0.002	+0.001	0	-0.001	-0.002
+1	+0.005	+0.004	+0.003	+0.002	+0.001	0	-0.001	-0.002	-0.003
0	+0.004	+0.003	+0.002	+0.001	0	-0.001	-0.002	-0.003	-0.004
-1	+0.003	+0.002	+0.001	0	-0.001	-0.002	-0.003	-0.004	-0.005
-2	+0.002	+0.001	0	-0.001	-0.002	-0.003	-0.004	-0.005	-0.006
-3	+0.001	0	-0.001	-0.002	-0.003	-0.004	-0.005	-0.006	-0.007
-4	0	-0.001	-0.002	-0.003	-0.004	-0.005	-0.006	-0.007	-0.008

PINION DEPTH SHIM ADJUSTMENT CHART (MILLIMETERS)

Old Pinion Marking	New Pinion Marking								
	-10	-8	-5	-3	0	+3	+5	+8	+10
+10	+0.20	+0.18	+0.15	+0.13	+0.10	+0.08	+0.05	+0.03	0
+8	+0.18	+0.15	+0.13	+0.10	+0.08	+0.05	+0.03	0	-0.03
+5	+0.15	+0.13	+0.10	+0.08	+0.05	+0.03	0	-0.03	-0.05
+3	+0.13	+0.10	+0.08	+0.05	+0.03	0	-0.03	-0.05	-0.08
0	+0.10	+0.08	+0.05	+0.03	0	-0.03	-0.05	-0.08	-0.10
-3	+0.08	+0.05	+0.03	0	-0.03	-0.05	-0.08	-0.10	-0.13
-5	+0.05	+0.03	0	-0.03	-0.05	-0.08	-0.10	-0.13	-0.15
-8	+0.03	0	-0.03	-0.05	-0.08	-0.10	-0.13	-0.15	-0.18
-10	0	-0.03	-0.05	-0.08	-0.10	-0.13	-0.15	-0.18	-0.20

3) The pinion depth adjustment number is determined by manufacturer at time of assembly. Number represents distance best running position of pinion shaft deviates from "nominal" or standard distance between pinion gear face and center line of axle. See Fig. 11.

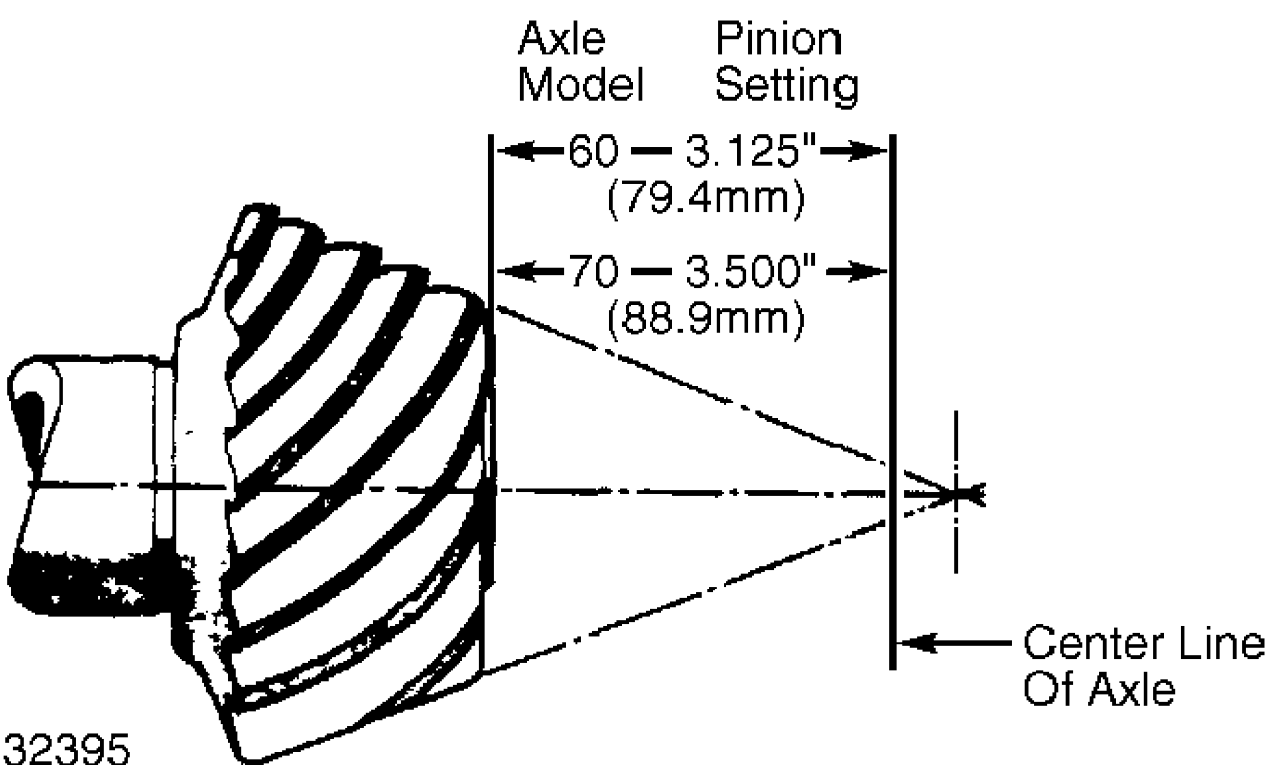


Fig. 11: Pinion Setting Standard Dimension

NOTE: Dimensions for Models 44, 61 and 80 not available.

NOTE: These are "nominal" distances from center of ring gear to

face of pinion shaft. Deviations are noted on pinion face.

4) Pinion Depth Gauge Set (D-271) allows shim pack adjustments to be made without having to remove and replace differential bearings. See Fig. 12.

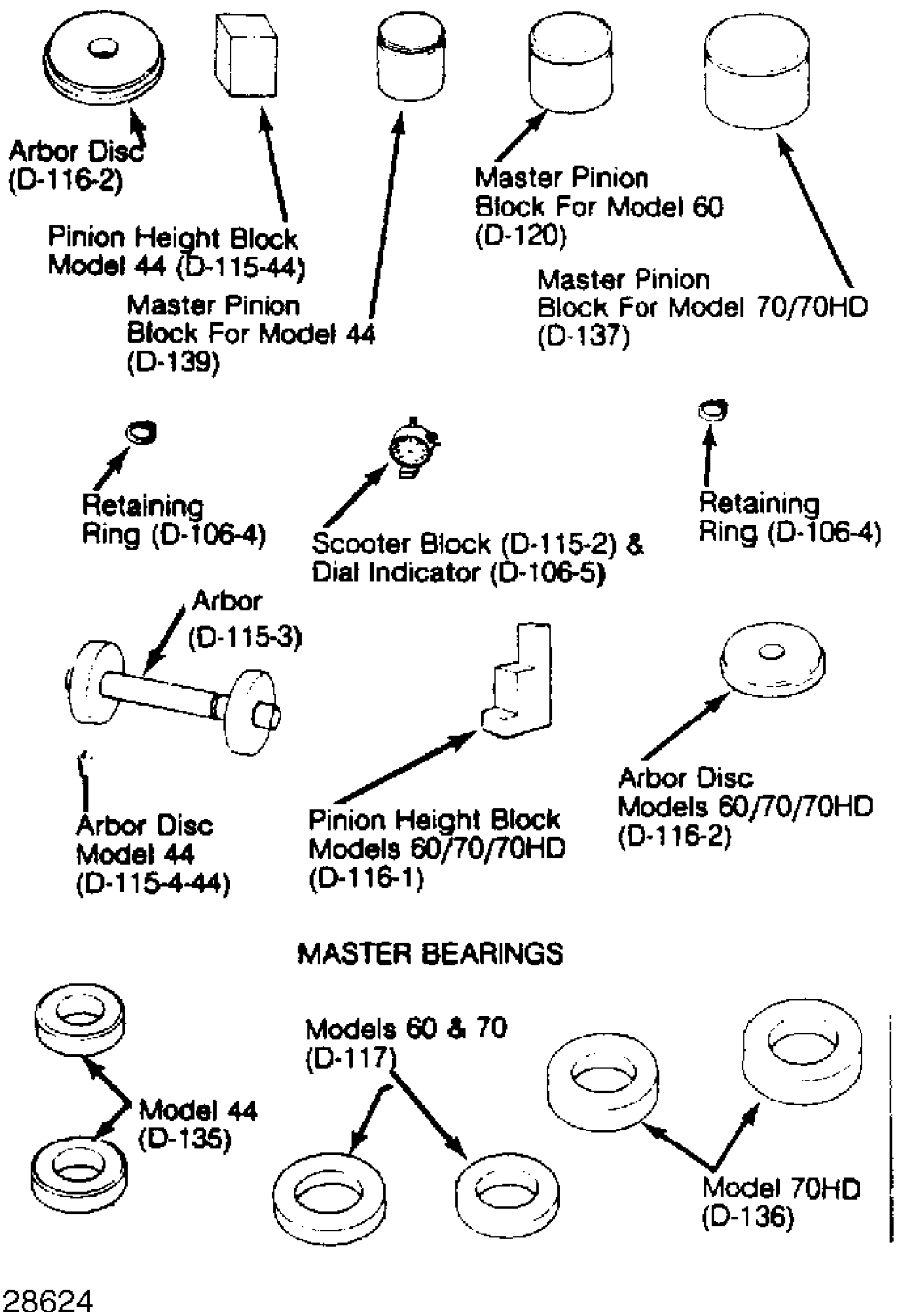


Fig. 12: Pinion Depth Gauge Set (D-271)

NOTE: This set can be used on Models 44, 60, 61, 70 and 80.

5) Place differential case in holding fixture or vise.

Lubricate all parts with gear oil. On one-piece case, place side gears and new thrust washers in case. Place differential pinions and new thrust washers in case. Rotate side gears until holes in pinion gears and washers line up with holes in case. Install differential pinion shaft. Install lock pin after aligning hole in shaft with hole in case. Peen edge of hole to keep pin in place.

6) On 2-piece case, Install side gears and new washers with pinion gears and cross shaft into half of case that is flanged. Put top half of case on bottom half. Align scribe marks made before disassembly. Tighten all bolts finger tight. Tighten bolts alternately to 65-70 ft. lbs. (88-95 N.m).

7) On all one and 2-piece case units, inspect ring gear and case for any burrs or nicks. Install ring gear and tighten NEW ring gear bolts evenly in alternating pattern to specification.

8) Install Master Bearings into case. Use (D-135) for Model 44 or (D-117) for Models 60, 61, 70 and 80. Install differential case in carrier. Install and tighten side bearing caps finger tight over master bearings. Caps must be in same location as marked during disassembly. Mount dial indicator on carrier with indicator tip against back of ring gear.

9) Pry case assembly to one side of carrier. Zero dial indicator and pry case in opposite direction. See Fig. 13. Record reading. This indicates thickness of shim pack necessary to eliminate clearance between case and side bearing races.

10) Actual placement of shim pack and necessary preload will be calculated after drive pinion is installed and pinion depth has been determined. Remove dial indicator. Remove bearing caps and differential case from carrier.

NOTE: If new differential side and pinion gears are used with new washers, gear backlash should be correct due to close machine tolerances. If old gears and/or washers are used, gear backlash must be checked.

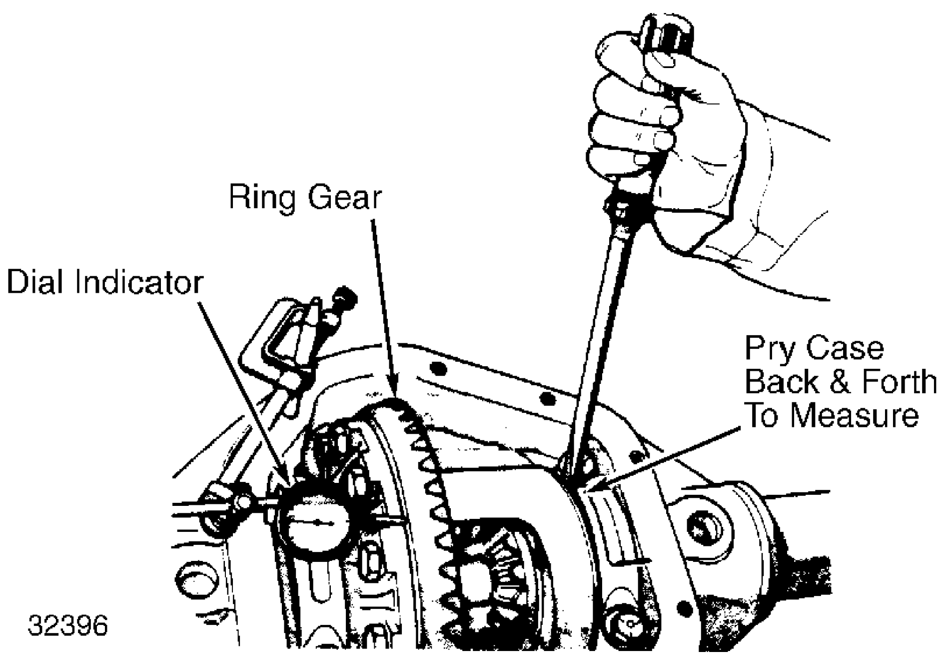


Fig. 13: Measuring Differential Case End Play

NOTE: If original ring and pinion is to be used, measure old shim packs and make up packs of same dimensions with new shims. Baffles are considered part of shim pack.

PINION DEPTH

1) Depth Gauge Set (D-271) is used to determine pinion depth. Place Master Pinion Block (D-139 on Model 44; D-120 on Model 60 and 61; D-137 on Model 70; T80T-4020-F42 on Model 80) in pinion bore of carrier. Put Arbor Discs (D-115-4-44 on Model 44; D-116-2 on Models 60,61 and 70; (T88T-4020-A) on Arbor (D-115-3). Install arbor in carrier with discs riding in bearing bore.

2) Put Pinion Height Block (D-115-1-44 on Model 44; D-116-1 on Models 60, 61, 70 and 80) on top of master pinion block with side against arbor. Place Scooter Block (115-2) with Dial Indicator (D-106-5) on small step of pinion height block. Zero dial indicator with scooter block flat on pinion height block.

3) Move scooter block so dial indicator tip touches arbor. Move block back and forth (perpendicular to arbor) to get highest reading. This reading, plus or minus value etched on pinion head, is thickness of shim pack necessary for pinion bearing.

4) On Model 80, Use Gauge Tube (D81T-4020-F51) and Gauge Block (D81T-4020-F56) to determine required thickness of shim pack.

5) On all models, measure shims separately with micrometer. If baffle is used, its thickness must be included in shim pack. This is also true if slinger is used between inner bearing and head of pinion shaft. Place pinion height shim pack in carrier bore for inner bearing race. Drive bearing race into carrier, making sure cup is fully seated.

PINION BEARING PRELOAD

1) Drive outer pinion bearing into carrier housing. Press inner pinion bearing onto pinion shaft using Press Tube (C-3095-A). Ensure bearing seats fully. Insert pinion shaft into carrier. Install outer bearing, slinger (if equipped), flange, washer and nut.

NOTE: Pinion preload shims and oil seal should NOT be installed at this time.

2) Using an INCH lb. torque wrench, tighten pinion nut until 10 INCH lbs. (1.13 N.m) rotational torque is required to move pinion shaft. Recheck pinion depth with arbor and discs at this time. Place pinion height block on face of pinion shaft.

3) Place dial indicator on small step of height block for Model 44, 60 and 61 axles. Place dial indicator on high step of block for Models 70 and 80 axles. Zero dial indicator and move it across arbor to get highest reading. If reading is within .002" (.05 mm) of etching on pinion face, pinion depth is correct.

NOTE: If pinion depth is not with .002" (.05 mm) of etched number on face of pinion, shim pack under inner bearing race must be changed before proceeding with differential settings.

4) Remove pinion nut, washer, flange, slinger and outer bearing. Place preload shims (removed during disassembly) on pinion. Install bearing and slinger. After lightly coating lips with gear oil, install pinion seal in carrier housing. Install flange, washer and NEW pinion nut. Tighten nut to specification. See TORQUE SPECIFICATIONS table at end of this article.

5) Using an INCH lb. torque wrench, measure preload (rotational torque) of pinion shaft. Rotational torque required to keep pinion shaft turning freely and smoothly should be 20-40 INCH lbs. (2.3-4.5 N.m). If preload needs to be increased, remove a few shims and recheck. To decrease preload, add a few shims and recheck. See Fig. 14.

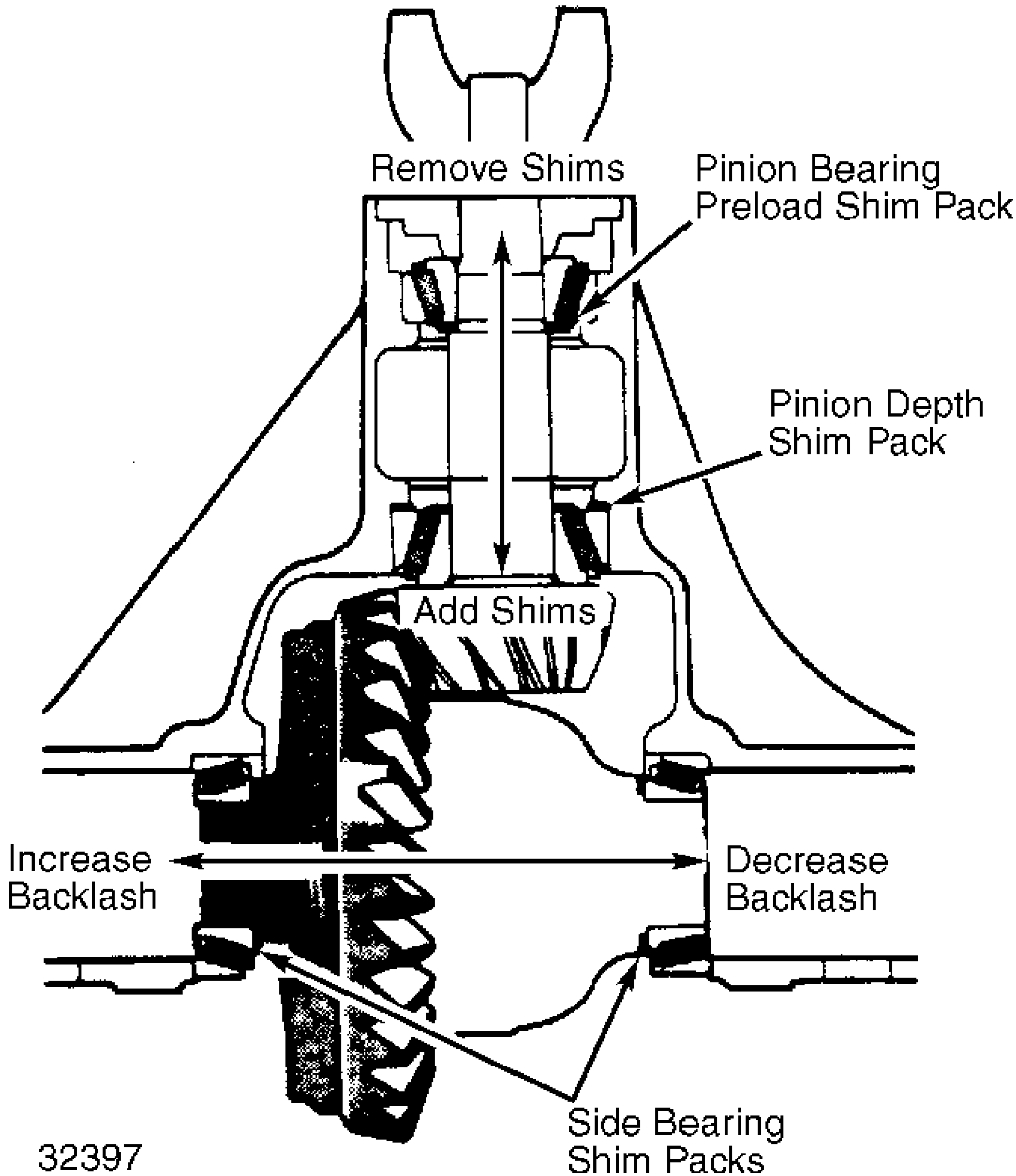


Fig. 14: Carrier Housing Shim Positioning

DIFFERENTIAL BEARING PRELOAD

1) Install differential case in housing with master bearings

on case. Set up dial indicator in same position as when case end play was checked. See Fig. 13. Press ring gear toward pinion head while rocking ring gear so teeth mesh fully. Zero dial indicator while holding ring gear into pinion gear.

2) Press differential case (ring gear) away from pinion gear. Repeat until dial indicator gives same reading each time. This figure is shim pack thickness necessary between case and side bearing on ring gear side. Remove dial indicator and differential from carrier. Remove master bearings from case.

3) Put calculated shim pack on hub of case at ring gear side. Place side bearing on hub. Use Bearing Installer (C-4025A) and Handle (C-4171) to drive bearing onto case until it is seated. Take remaining shim pack as determined from case end play measurement and install pack on opposite side of case from ring gear.

4) Add .015" (.38 mm) thickness to shim pack opposite ring gear to provide side bearing preload. Drive side bearing onto case with installer and handle. Install spreader and dial indicator on carrier housing. Spread housing .015" (.38 mm). Put side bearing races onto side bearings. Install differential case into carrier.

RING & PINION BACKLASH

1) Install side bearing caps, making sure reference marks made on caps and carrier match. Tighten cap bolts to 80 ft. lbs. (108 N.m). Check backlash between ring and pinion gears at 3 points spaced equal distance on ring gear. See Fig. 15.

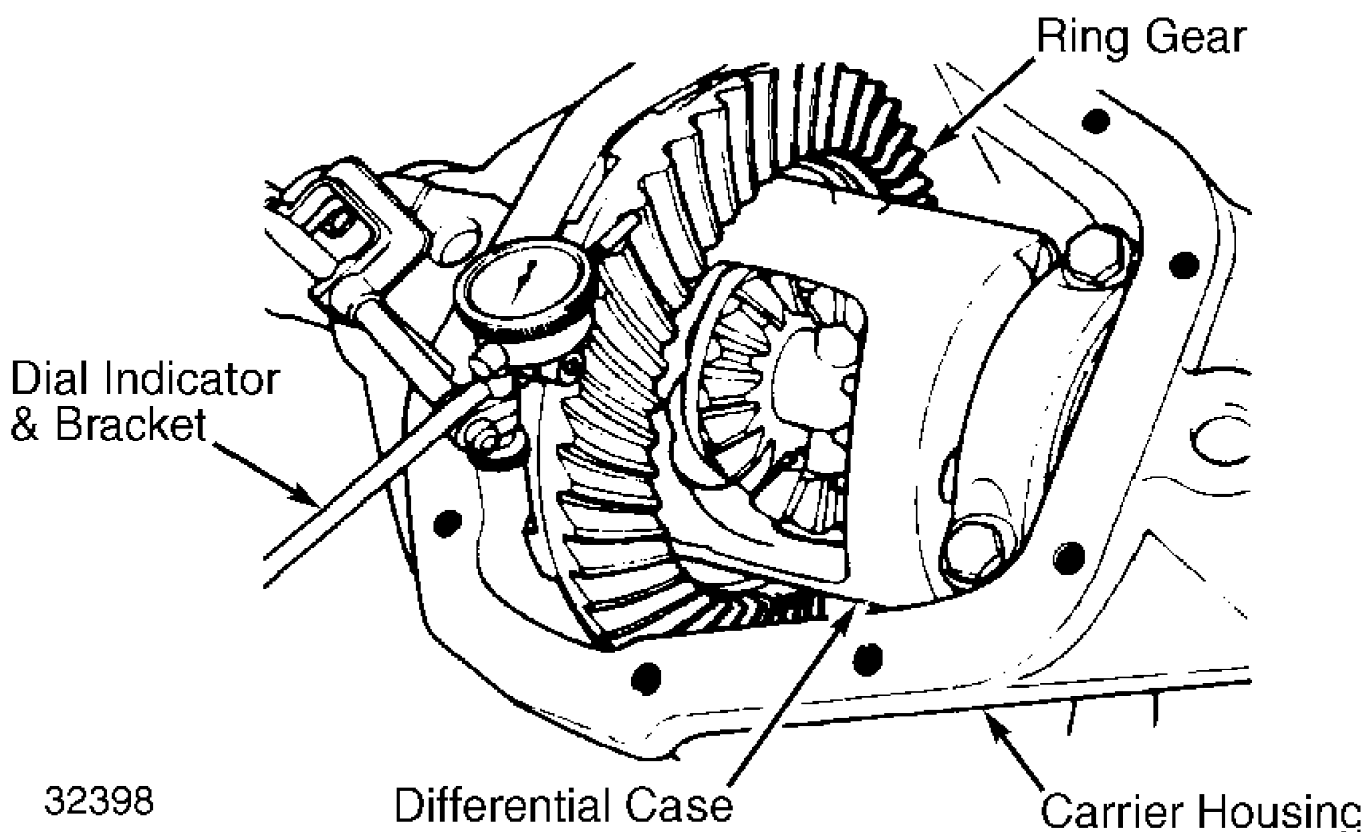


Fig. 15: Measuring Backlash Between Ring & Pinion Gears

2) Backlash reading between ring and pinion gears should be .004-.009" (.10-.23 mm). Maximum variation between readings at 3 points is .002" (.05 mm). If backlash is too high, move ring gear

closer to pinion gear. If backlash is too low, move ring gear away from pinion gear.

3) To change backlash readings, move shims from one side of differential case to other. When backlash adjustment is completed, check tooth contact pattern. See GEAR TOOTH CONTACT PATTERNS in this section. Pattern should be correct if assembly and adjustments have been done properly.

4) When differential is complete and correctly adjusted, install new cover gasket and cover. Tighten cover bolts to 30-40 ft. lbs. (41-54 N.m). Fill assembly with hypoid lubricant.

AXLE ASSEMBLY SPECIFICATIONS TABLE

Application	Specifications In. (mm)
Pinion Gear Depth (Nominal Dimension)	
Model 44	2.625 (66.68)
Model 60 & 61	3.125 (79.38)
Model 70 & 80	3.500 (88.90)
Ring Gear Backlash	.004-.009 (.10-.23)
Side Bearing Preload	.015 (.38)
	INCH lbs. (N.m)
Pinion Bearing Preload	
New Bearings	20-40 (2.3-4.5)
Used Bearings	10-20 (1.1-2.3)

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS TABLE

Applications	Ft. Lbs. (N.m)
Axle Flange-to-Hub Bolt	
Model 44	35 (48)
Models 60 & 61	55 (75)
Model 70 & 80	85 (115)
Pinion Shaft Flange Nut	
Models 44 & 70	210 (285)
Models 60 & 61	270 (367)
Model 80	440-500 (597-678)
Ring Gear-to-Case Bolt	
Model 44	55 (75)
Models 60, 61, & 70	110 (149)
Model 80	145-165 (196-223)
Side Bearing Cap Bolt	80 (108)
Front Axle	
Cherokee, Comanche, & Wagoneer	
Axle Shaft Nut	175 (237)
Disconnect Housing Bolt	10 (14)
Hub-to-Knuckle Bolt	75 (102)
Lower Control Arm Bolt	133 (180)
Lower Shock Mount Bolt	14 (19)
Drive Shaft Bolt	14 (19)
Stabilizer Bar Link Bolt	70 (95)
Tie Rod Nut	25-45 (34-61)
Upper Control Arm Bolt	37 (50)
Wheel Lug Nut	75 (102)
Grand Wagoneer	
Leaf Spring "U" Bolt Nut	100 (136)
Lower Shock Mount Bolt	45 (61)

Drive Shaft Bolt	16 (22)
Spindle Attaching Nut	65 (88)
Tie Rod Nut	60 (80)
Wheel Lug Nut	80 (108)

DRIVE AXLE RATIO IDENTIFICATION

1988 Drive Axles - Axle Ratio Identification

Jeep

IDENTIFICATION

Front and rear axle identification number is cast into left side of cover or into axle housing, adjacent to housing cover.

JEEP FRONT AXLE RATIO IDENTIFICATION

Application	Ratio
Cherokee, Comanche, Grand Wagoneer & Wagoneer	3.07:1, 3.55:1, 4.10:1, 4.56:1
Wrangler	3.07:1, 3.54:1, 3.55:1, 4.10:1, 2.73:1

JEEP REAR AXLE RATIO IDENTIFICATION

Application	Ratio
Cherokee, Comanche, Grand Wagoneer & Wagoneer	3.08:1, 3:55:1, 4.11:1, 4.56:1
Wrangler	3.08:1, 3.55:1, 4.11:1

DRIVE AXLE - STANDARD

1988 Jeep Cherokee

1988 DRIVE AXLES
Jeep 7 9/16" & 8 7/8" Ring Gear

All Models

DESCRIPTION

The rear axle assembly is a hypoid gear type with integral carrier housing. The standard axle uses a 7 9/16" (192 mm) diameter ring gear. The heavy duty axle uses an 8 7/8" (225 mm) diameter ring gear. See Fig. 1.

IDENTIFICATION

Axle assembly has 10-bolt rear cover. The axle ratio and ring and pinion gear tooth combinations are stamped on a tag attached to differential housing cover.

AXLE RATIO IDENTIFICATION

Axle Ratio	Tooth Combinations	Ring Gear Diameter
3.31:1	13/43	7 9/16" (192 mm)
3.54:1	13/46	7 9/16" (192 mm)
4.11:1	9/37	7 9/16" (192 mm)
4.10:1	10/41	8 7/8" (225 mm)

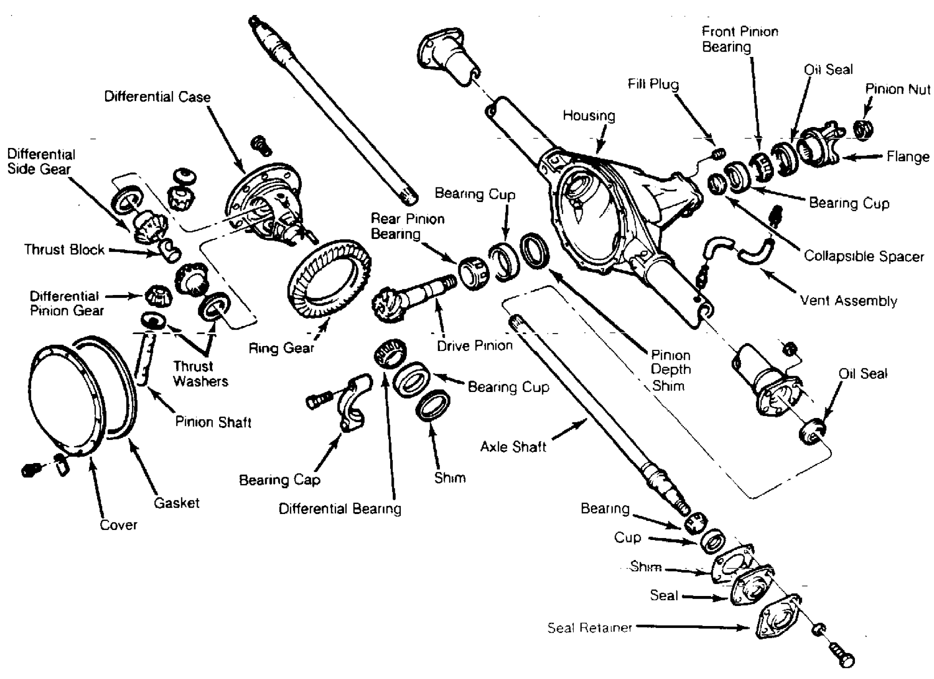


Fig. 1: Exploded View of Rear Axle Assembly

REMOVAL & INSTALLATION

AXLE SHAFTS & BEARINGS

1) Raise and support vehicle. Remove rear wheel and brake drum. Remove axle shaft retaining nuts. Remove axle shaft from axle tube and mount in vise. Drill a 1/4" hole 3/4 of the way through retaining ring. Use care not to drill into axle shaft.

2) Cut the ring with a chisel and remove it from the shaft. Remove bearing from axle shaft using arbor press. Remove axle seal. See Fig. 2.

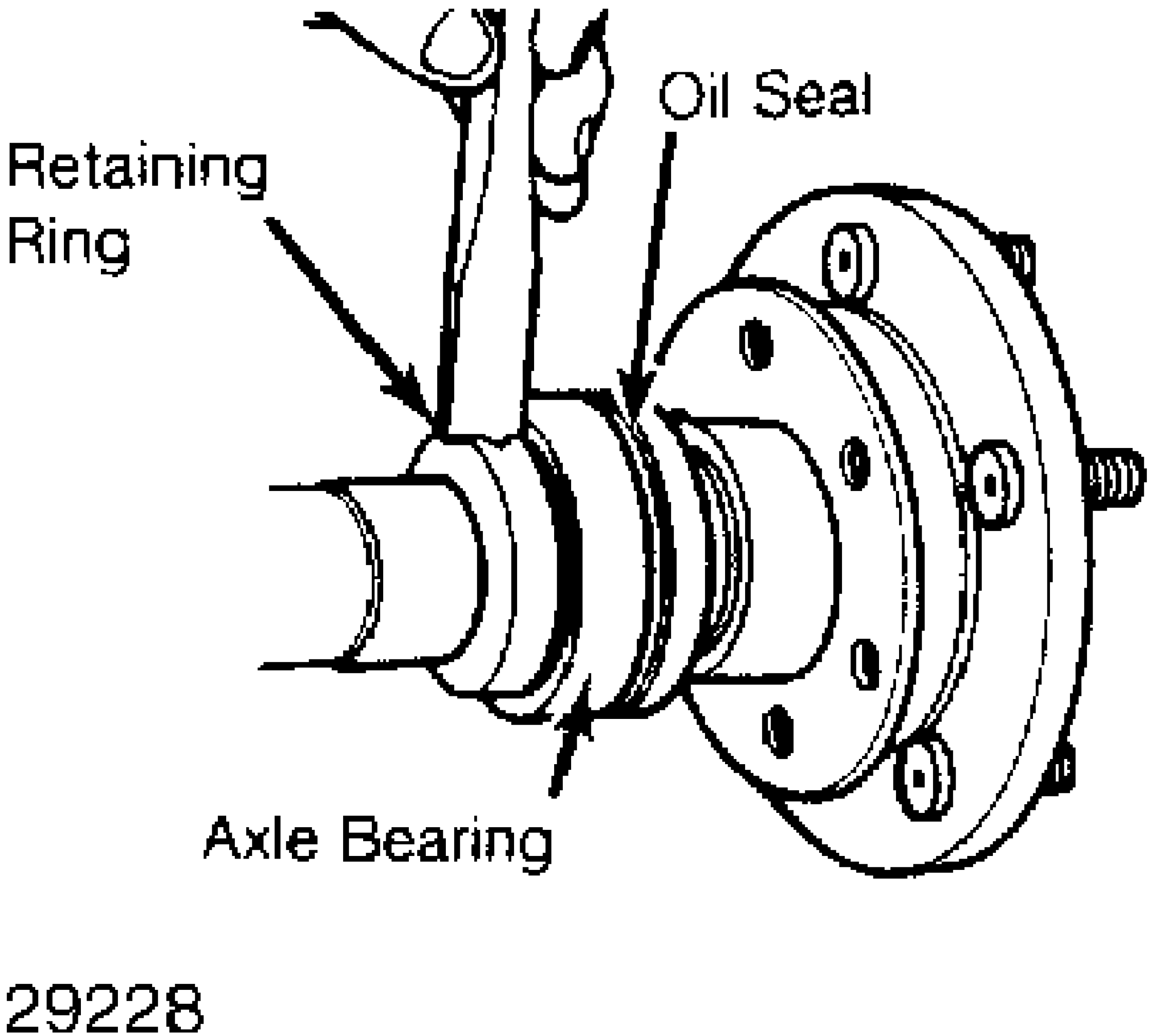


Fig. 2: Removing Axle Bearing Retaining Ring

Installation

1) Pack wheel bearing with grease. Coat inner axle shaft seal with axle grease and outer portion of seal with gasket sealant.

2) Ensure components are correctly placed upon axle. Using Bearing Installer (J-22912-01), press axle shaft bearing and new retainer ring on axle shaft. Ensure bearing and retainer ring are seated against axle shaft shoulder. Apply a thin coat of bearing

lubricant to axle flange bearing bore and install axle.

YOKE & PINION OIL SEAL

Removal

1) Raise and support vehicle. Remove wheels and brake drums. Mark and remove drive shaft. Using an INCH lb. torque wrench, record torque required to rotate pinion several revolutions.

2) Hold yoke from turning and remove pinion nut. Mark drive pinion shaft and yoke for reassembly reference. Remove yoke and pinion oil seal.

Installation

1) Coat new seal with rear axle lubricant and install. Align marks made at disassembly and install yoke. Install new pinion nut and tighten just enough to remove end play.

CAUTION: DO NOT overtighten pinion nut. If desired preload is exceeded, a new collapsible pinion spacer sleeve must be installed and drive pinion preload reset.

2) Using an INCH lb. torque wrench, check torque required to turn pinion. Refer to torque reading recorded during disassembly and add 5 INCH lbs. (.6 N.m) for correct preload. Tighten pinion nut slightly and recheck preload. Repeat procedure until desired preload is obtained.

REAR AXLE ASSEMBLY

Removal

1) Raise and support vehicle. Remove wheels and brake drums. Disconnect brake hose-to-axle connection and plug line.

2) Disconnect parking brake cable at brake equalizer. Mark and remove drive shaft. Disconnect track bar at axle bracket (if equipped). Remove axle vent tube at axle. Support axle assembly. Remove spring "U" bolts and tie plates.

3) Loosen, but do not remove, bolts which attach front of rear spring to frame brackets. Lift axle to relieve axle weight from springs and remove bolts retaining springs to shackles. Lower springs to floor. Lower jack and remove axle assembly.

NOTE: Factory axles are shipped without lubricant. When adding lubricant, position axle horizontally with yoke end of pinion housing facing downward. Turn pinion shaft several times to lubricate bearings.

Installation

1) To install, support axle assembly with jack and slide axle into place. Raise, align and install spring-to-frame and shackle bolts. Tighten spring-to-frame and shackle bolts to 111 ft. lbs. (150 N.m). Install brake hose, axle vent tube and parking brake cable. Align and connect drive shaft.

2) Bleed hydraulic system and adjust parking brake cable. Ensure axle is filled with 75-90W gear lubricant. Ensure spring centering bolt heads are seated in axle spring seat before tightening "U" bolts.

OVERHAUL

DISASSEMBLY

NOTE: It is not necessary to remove axle assembly from vehicle to

perform overhaul.

1) Raise and support rear of vehicle. Remove rear cover and drain lubricant. Remove wheels, brake drums, hubs and axle shafts.

2) Mark differential bearing caps for reassembly reference and loosen them until a few threads remain engaged. Pry differential loose and remove bearing caps and differential from housing.

3) Mark bearing caps, races and shims for reassembly reference. Remove differential side bearings with a puller. Remove differential and ring gear from case. Remove pinion shaft lock pin.

4) Using 2 feeler gauges, measure differential side gear clearance. Insert an equal distance feeler gauge between each side gear and case. Continue checking clearance until each feeler gauge is a tight drag fit. Ensure side clearance does not exceed .007" (.18 mm) on either side. If side gear clearance exceeds specification, replace side gear thrust washers.

5) Remove pinion yoke and nut. Retain pinion nut for pinion depth adjustment during reassembly. Tap pinion gear end with a soft faced mallet to release it from front bearing. Remove pinion gear, pinion bearings and preload collapsible spacer. Discard collapsible spacer.

6) Remove pinion seal and pinion rear bearing cup. Remove and retain pinion depth shim located under rear bearing cup. Remove pinion front bearing cup. Using a press, remove pinion gear rear bearing.

CLEANING & INSPECTION

Clean all components in solvent and dry with compressed air. Inspect all components for excessive wear or damage and replace as necessary.

REASSEMBLY

NOTE: Ensure correct shims have been chosen to obtain proper ring gear backlash and bearing preload before reassembly. See ADJUSTMENTS in this article.

Drive Pinion

1) Press rear bearing on pinion stem with large diameter of roller cage toward gear. Clean housing bearing bores. Place shim in rear bearing bore and install rear bearing cup.

NOTE: When installing a new gear set, use original depth shim as a starting point. Chamfered side of shim must be installed to bottom side of rear bearing cup bore.

2) Install front bearing cup into housing. Install drive pinion through rear bearing cup. Install front bearing, yoke and original pinion nut. Tighten nut to remove bearing end play only.

NOTE: A new nut and collapsible spacer are not installed at this time, as pinion will be removed after a depth measurement.

Differential Case

1) Assemble side gears and thrust washers and install into differential case. Ensure side gear thrust washers were replaced in clearance measured at disassembly was greater than .007" (.18 mm).

2) Install differential pinions and thrust washers in case. Ensure pinions are aligned with shaft bores. Recheck side gear clearance. If clearance exceeds .007" (.18 mm), side gears must be replaced.

3) Install differential pinion shaft and lockpin. Using Remover (J-22912-01), remove differential bearings. Install correct

size end play shims on each side of differential case. Position and install ring gear on differential case. Install replacement ring gear bolts and tighten standard axle ring gear bolts to 70-90 ft. lbs. (95-122 N.m). Tighten heavy duty drive axle bolts to 105 ft. lbs. (142 N.m).

4) Check ring gear backlash. See RING GEAR BACKLASH in ADJUSTMENTS. Lightly lubricate differential bearings, cups, gears and thrust washers with axle lubricant. Install bearing cups on differential bearings. Install differential in axle housing.

5) Using a soft faced hammer, tap outer edges of differential bearing cups to seat them in housing. Install differential bearings caps and tighten cap bolts to 57 ft. lbs. (77 N.m).

6) Recheck and verify ring gear backlash has not changed. Install axle housing cover. Tighten cover bolts to 14 ft. lbs. (19 N. m). Refill axle with 75-90W gear lubricant.

ADJUSTMENTS

DRIVE PINION DEPTH

1) Check numbers painted on drive pinion and ring gear. First number on pinion must match number on ring gear. Second number on pinion is pinion depth variance. If number is preceded by a plus sign, add that number to standard pinion depth. If number is preceded by a minus sign, subtract that amount from standard pinion depth. This will give desired pinion depth. Record this measurement for future reference.

2) If numbers painted on drive gear and ring gear do not match, gears are not a matched set and should not be used. Some factory installed sets may have .01" (.25 mm) or .02" (.50 mm) machined off pinion end face.

3) Identifying numbers will appear as "+23". Number "2" indicates .02" (.50 mm) was removed from end face and number "3" is pinion depth variance. If marked "+16", number "1" indicates .010" (.25 mm) was removed from end face and number "6" is pinion depth variance.

4) Standard pinion depth on standard drive axle is 2.095" (53.21 mm). Standard pinion depth on heavy duty drive axle is 2.547" (64.69 mm).

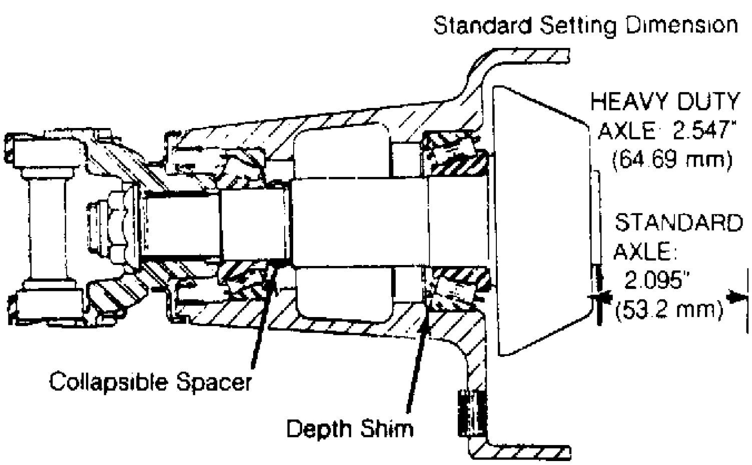


Fig. 3: Pinion Depth & Preload Shim Location

5) Measure thickness of original pinion depth shim. Note pinion depth variance numbers marked on old and new pinion gears. Refer to PINION DEPTH SHIM ADJUSTMENT SPECIFICATIONS at end of this

article and determine amount to be added or subtracted from original shim thickness to obtain starter shim thickness. DO NOT use starter shim thickness as a final shim setting.

6) Install rear bearing on pinion gear. On heavy duty rear axle, large end of bearing faces gear end of pinion. Press bearing against rear face of gear.

7) On all axles, clean pinion bearing bores in axle housing to ensure accurate measurement. Install and center starter shim in housing bearing cup bore. If shim is chamfered, ensure chamfered side faces bottom of bearing cup bore.

8) Install pinion rear and front bearing cups. Install pinion gear in rear bearing cup and install pinion front bearing and yoke on pinion gear. DO NOT install oil seal or collapsible spacer at this time. Install and tighten original pinion nut only enough to remove end play. Determine depth variance marked on pinion gear.

9) Install Arbor (J-5223-4) and Discs (J-5223-23) in differential bearing cup bores. Ensure discs are fully seated in bearing cup bores. Install bearing caps over discs and install bearing cap bolts. Tighten bolts, but not to specified torque.

10) Position Gauge Block (J-5223-20) against end of drive pinion with Clamp (J-5223-24) and Bolt (J-5223-29). See Fig. 4. Extend clamp bolt until it presses against gauge block enough to prevent gauge block from moving.

11) Loosen thumbscrew in end of gauge block to allow plunger to contact arbor. When plunger contacts arbor, tighten thumbscrew, taking care not to disturb plunger position.

12) Remove gauge block and measure distance from end of anvil to top of plunger head, using a 2-3" (51-76 mm) micrometer. Record this measured pinion depth for future reference.

13) Remove gauging tools, drive pinion and rear bearing cup. Remove drive pinion depth shim and record thickness. Add shim thickness to measured pinion depth. From this total subtract desired pinion depth. For an example, see DETERMINING CORRECT SHIM THICKNESS table.

DETERMINING CORRECT SHIM THICKNESSES

Application	In. (mm)
Standard Drive Axle	
Standard Pinion Depth	2.095 (53.21)
Pinion Depth Variance	- .004 (.10)
Desired Pinion Depth	=2.091 (53.11)
Measured Pinion Depth	2.100 (53.34)
Starting Shim Thickness	+ .096 (.096)
Total Measured Thickness Depth	=2.196 (55.77)
Total Measured Pinion Depth	2.196 (55.77)
Desired Pinion Depth	-2.091 (53.11)
Correct Shim Thickness	=.105 (2.66)
Heavy Duty Drive Axle	
Standard Pinion Depth	2.547 (64.69)
Pinion Depth Variance	+ .007 (.18)
Desired Pinion Depth	=2.554 (64.87)
Measured Pinion Depth	2.550 (64.77)
Starting Shim Thickness	+.098 (2.49)
Total Measured Pinion Depth	=2.648 (67.26)
Total Measured Pinion Depth	2.648 (67.26)
Desired Pinion Depth	-2.554 (64.87)
Correct Shim Thickness	=.094 (2.39)

14) The result represents correct shim thickness to be installed. Install correct thickness shim in rear bearing bore and

install rear bearing cup. See Fig. 3.

NOTE: Replacement pinion gears marked more than .009" (.23 mm) should not be used.

15) See PINION DEPTH SHIM ADJUSTMENT SPECIFICATIONS to determine appropriate starter shim thickness when installing NEW gear sets. Note pinion variance numbers on new and old gear. Follow old pinion marking line across to new pinion marking column.

16) The number in box indicates change in shim thickness from original. For example, old pinion marked "-3" and new pinion marked "+2". Intersecting box shows -.005" (.13 mm) to be subtracted from original shim thickness.

17) Starter shim thickness must not be used as a final shim setting. An actual pinion depth measurement must be made and final shim thickness should be adjusted as necessary.

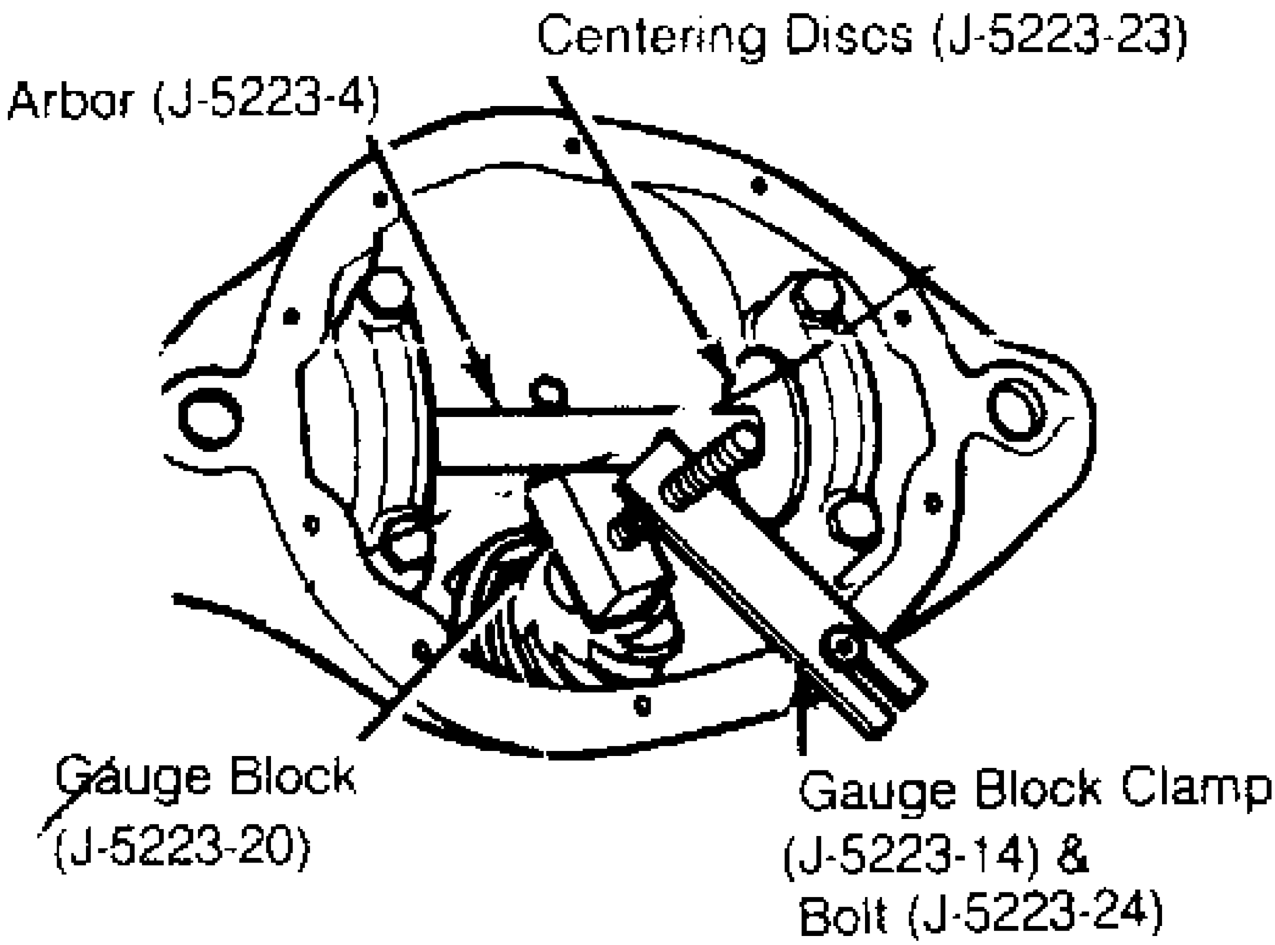


Fig. 4: Measuring Pinion Depth

DRIVE PINION BEARING PRELOAD

1) Install new collapsible spacer and front bearing on drive pinion. Install oil seal, yoke and nut. Tighten pinion nut only enough to remove bearing end play.

CAUTION: Never reuse collapsible spacer.

2) Slowly tighten pinion nut until torque required to rotate pinion gear is 15-25 INCH lbs. (2-3 N.m). Check torque frequently and only tighten nut in small amounts.

CAUTION: DO NOT overtighten pinion nut. If preload torque is exceeded, collapsible spacer must be replaced and preload reset.

DIFFERENTIAL BEARING END PLAY

1) Place bearing cup over each differential bearing. Install differential case assembly (without drive gear) in axle housing. On standard drive axles, install a .142" (3.60 mm) shim on each side of differential bearing cup and housing. On heavy duty drive axles, install a .080" (2.03 mm) shim on each side of differential bearing cup and housing.

2) Install bearing caps and tighten bolts finger tight. Mount dial indicator to housing so indicator button touches ring gear face of differential case. Prying between shims and housing, move assembly to one side. Zero dial indicator, then pry assembly to opposite side. Read and record indicator reading. DO NOT zero or read indicator while prying.

3) Amount read on indicator is shim thickness which must be added in order to arrive at a no preload or end play condition. Shims are available in thicknesses of .142" (3.60 mm) to .174" (4.41 mm) in .002" (.050 mm) increments.

4) When all side play is eliminated, check drive gear face of case for runout. Runout should not exceed .002" (.050 mm). Remove case from housing and retain shims used to eliminate side play. See Fig. 5.

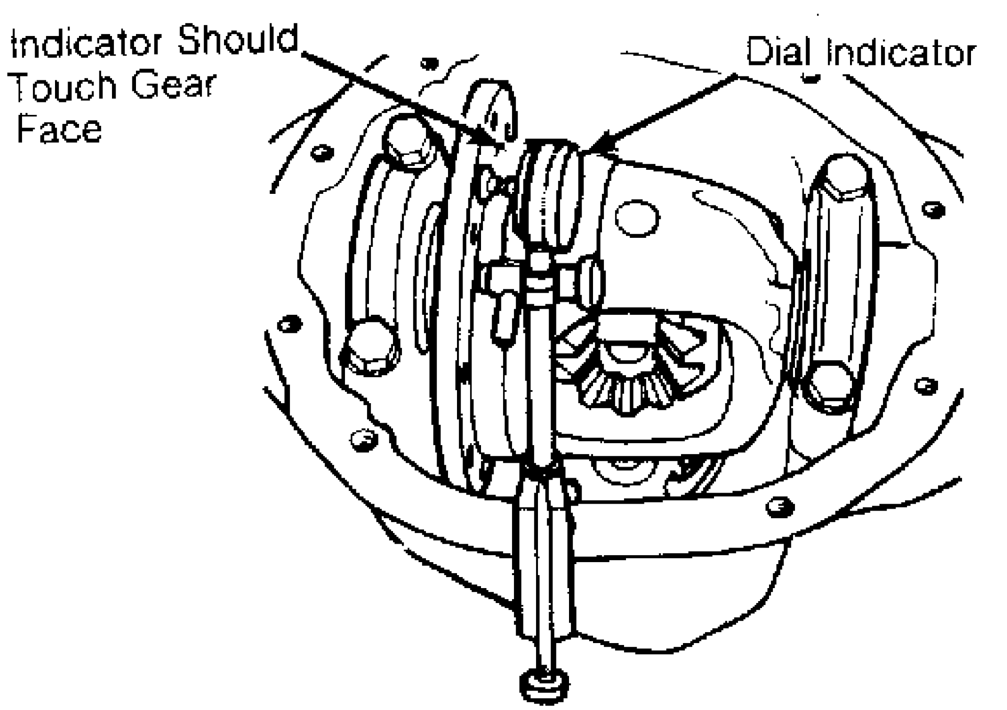


Fig. 5: Differential Bearing End Play & Runout Measurement

RING GEAR BACKLASH ADJUSTMENT

1) Install differential and ring gear assembly in housing

using shims selected to remove end play. Tighten bearing cap bolts evenly to 57 ft. lbs. (77 N.m) for standard drive axle and 85 ft. lbs. (115 N.m) for heavy duty drive axle. Attach a dial indicator to housing so button of indicator contacts drive side of a tooth of ring gear, at a right angle to tooth. See Fig. 6. Rock ring gear and note movement on dial indicator.

2) Backlash should be .005-.009" (.13-.23 mm) with .008" (.20 mm) desired. To increase backlash, install thinner shim on ring gear side of case and a thicker shim on opposite side of case. To decrease backlash, reverse placement of shims. DO NOT change total shim thickness, alter positions only.

DIFFERENTIAL BEARING PRELOAD

1) Differential bearings are preloaded by increasing existing shim thickness by .004" (.10 mm). Install differential bearing shims in axle housing bearing bore. DO NOT distort shims by hammering them into housing.

2) Assemble bearing cups on bearings (cups should completely cover rollers). Position differential so bearings just start to enter in axle housing bearing bores. Keep assembly square in housing and push in as far as possible.

3) Using a soft hammer, tap outer edge of bearing cups until seated in housing. Install bearing caps, aligning marks made at disassembly. Install and tighten bolts. Preloading differential bearings may change backlash setting so recheck backlash and correct as necessary.

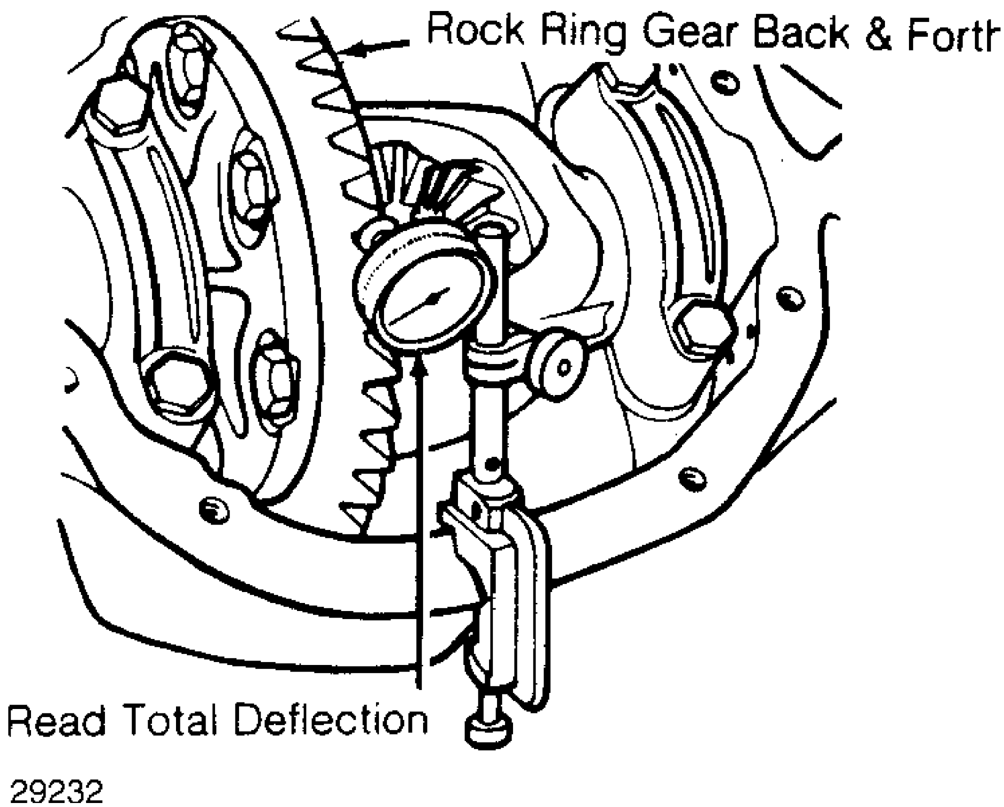


Fig. 6: Checking Ring Gear Backlash

4) After all adjustments, check gear tooth pattern. See the GEAR TOOTH CONTACT PATTERNS article in this section.

AXLE ASSEMBLY SPECIFICATIONS TABLE

Application	Specification
Axle Shaft End Play	.004-.008" (.10-.20 mm)
Differential Bearing Preload	.008" (.20 mm)
Differential Case Face Runout	.002" (.05 mm)
Differential Side Gear Case Clearance	0-.007" (0-.18 mm)
Oil Capacity	
Standard Drive Axle	2.5 pts. (1.2L)
Heavy Duty Drive Axle	4.7 pts (2.2L)
Pinion Bearing Preload	15-25 INCH lbs. (2.3 N.m)
Pinion Gear Depth (Standard)	
Standard Drive Axle	2.095" (53.21 mm)
Heavy Duty Drive Axle	2.547" (64.7 mm)
Ring Gear	
Backlash	.005-.009" (.13-.23 mm)
Preferred	.008" (.20 mm)

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS TABLE

Application	Ft. Lbs. (N.m)
Axle Housing Cover	14 (19)
Axle-to-Leaf Spring "U" Bolts	52 (70)
Brake Support Plate Bolts	32 (43)
Differential Bearing Bolts	
Standard Drive Axle	57 (77)
Heavy Duty Drive Axle	85 (115)
Rear Axle Filler Plug	
Standard Drive Axle	25 (34)
Heavy Duty Drive Axle	15 (20)
Rear Spring Front Bolt	111 (150)
Rear Spring Rear Shackle Nuts	111 (150)
Ring Gear Bolts	
Standard Drive Axle	70-90 (95-122)
Heavy Duty Drive Axle	105 (142)
Shock Absorber-to-Axle Nut	44 (60)
Universal Joint Clamp Strap Bolts	14 (19)
Wheel Lug Nuts	75 (102)

PINION DEPTH SHIM ADJUSTMENT SPECIFICATIONS

PINION DEPTH SHIM ADJUSTMENT CHART (INCHES)

Old Pinion Marking	Specification
+4	
New Pinion Marking	
-4	+0.008
-3	+0.007
-2	+0.006
-1	+0.005
0	+0.004
+1	+0.003
+2	+0.002
+3	+0.001
+4	0

+3

New Pinion Marking

−4	+0.007
−3	+0.006
−2	+0.005
−1	+0.004
0	+0.003
+1	+0.002
+2	+0.001
+3	0
+4	−0.001

+2

New Pinion Marking

−4	+0.006
−3	+0.005
−2	+0.004
−1	+0.003
0	+0.002
+1	+0.001
+2	0
+3	−0.001
+4	−0.002

+1

New Pinion Marking

−4	+0.005
−3	+0.004
−2	+0.003
−1	+0.002
0	+0.001
+1	0
+2	−0.001
+3	−0.002
+4	−0.003

0

New Pinion Marking

−4	+0.004
−3	+0.003
−2	+0.002
−1	+0.001
0	0
+1	−0.001
+2	−0.002
+3	−0.003
+4	−0.004

−1

New Pinion Marking

−4	+0.003
−3	+0.002
−2	+0.001
−1	0
0	−0.001
+1	−0.002
+2	−0.003
+3	−0.004
+4	−0.005

−2

New Pinion Marking

−4	+0.002
−3	+0.001
−2	0
−1	−0.001
0	+0.001
+1	+0.002

+2	+0.003
+3	+0.003
+4	+0.004

-3

New Pinion Marking

-4	+0.001
-3	+0.002
-2	+0.001
-1	0
0	-0.001
+1	-0.002
+2	-0.003
+3	-0.004
+4	-0.005

-4

New Pinion Marking

-4	0
-3	-0.001
-2	-0.002
-1	-0.003
0	-0.004
+1	-0.005
+2	-0.006
+3	-0.007
+4	-0.008

PINION DEPTH SHIM ADJUSTMENT CHART (MILLIMETERS)

Old Pinion Marking	Specifications

+10

New Pinion Marking

-10	+0.20
-8	+0.18
-5	+0.15
-3	+0.13
0	+0.10
+3	+0.08
+5	+0.05
+8	+0.03
+10	0

+8

New Pinion Marking

-10	+0.18
-8	+0.15
-5	+0.13
-3	+0.10
0	+0.08
+3	+0.05
+5	+0.03
+8	0
+10	-0.03

+5

New Pinion Marking

-10	+0.15
-8	+0.13
-5	+0.10
-3	+0.08
0	+0.05
+3	+0.03
+5	0
+8	-0.03

+10 .... -0.05

+3

New Pinion Marking

-10 .... +0.13
-8 .... +0.10
-5 .... +0.08
-3 .... +0.05
0 .... +0.03
+3 0
+5 .... -0.03
+8 .... -0.05
+10 .... -0.08

0

New Pinion Marking

-10 .... +0.10
-8 .... +0.08
-5 .... +0.05
-3 .... +0.03
0 0
+3 .... -0.03
+5 .... -0.05
+8 .... -0.08
+10 .... -0.10

-3

New Pinion Marking

-10 .... +0.08
-8 .... +0.05
-5 .... +0.03
-3 0
0 .... -0.03
+3 .... -0.05
+5 .... -0.08
+8 .... -0.10
+10 .... -0.13

-5

New Pinion Marking

-10 .... +0.05
-8 .... +0.03
-5 0
-3 .... -0.03
0 .... -0.05
+3 .... -0.08
+5 .... -0.10
+8 .... -0.13
+10 .... -0.15

-8

New Pinion Marking

-10 .... +0.03
-8 0
-5 .... -0.03
-3 .... -0.05
0 .... -0.08
+3 .... -0.10
+5 .... -0.13
+8 .... -0.15
+10 .... -0.18

-10

New Pinion Marking

-10 0
-8 .... -0.03
-5 .... -0.05
-3 .... -0.08
0 .... -0.10

+3	−0.13
+5	−0.15
+8	−0.18
+10	−0.20

DRIVE BELT ROUTING

1988 Jeep Cherokee

1983-88 ENGINE COOLING
Jeep Drive Belt Routing

Cherokee, Comanche, Wagoneer, Wrangler, Grand Wagoneer

DESCRIPTION

Two drive belt systems are used on Jeep vehicles. The conventional V-Belt and the single Serpentine or V-Ribbed belt.

The single (Serpentine or V-Ribbed) drive belt system has been adopted by several manufacturers as a replacement for multiple V-Belt systems previously offered. The Serpentine belt requires a suitable belt tensioner similar to those used to control timing belt tension.

Use of a tensioner allows engine accessories to be mounted rigidly on the engine. The single belt drive system has a predicted life of 100,000 miles before replacement is required.

The belt tensioner has a wide functional range and is capable of maintaining tension during the expected life of the belt. Tensioner cannot compensate for extreme belt lengths. Poor tension control and possible tensioner damage can result from excessive belt length.

INSPECTION

Inspect belt for fraying. If fraying has occurred, ensure belt and tensioner are aligned properly. See Fig. 1. If tensioner has reached its limit of travel, belt is excessively stretched and replacement of belt is required. If excessive noise is noticed from tensioner or idler, check for possible bearing failure. Small cracks in the back of the belt are acceptable. Do not apply "Belt Dressing" or any other additive to serpentine belt.

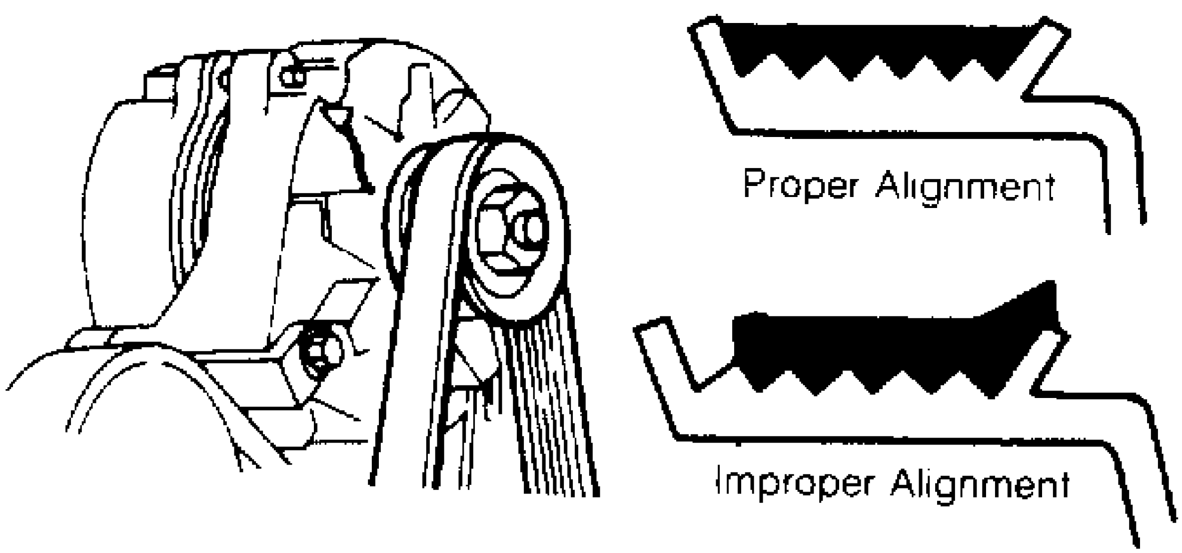


Fig. 1: Serpentine Belt Alignment
Courtesy of Ford Motor Co.

DRIVE BELT ROUTING

CHEROKEE

Install belt on crankshaft and belt-driven components as shown. Adjust tensioner. See Figs. 2 and 3.

1983-88

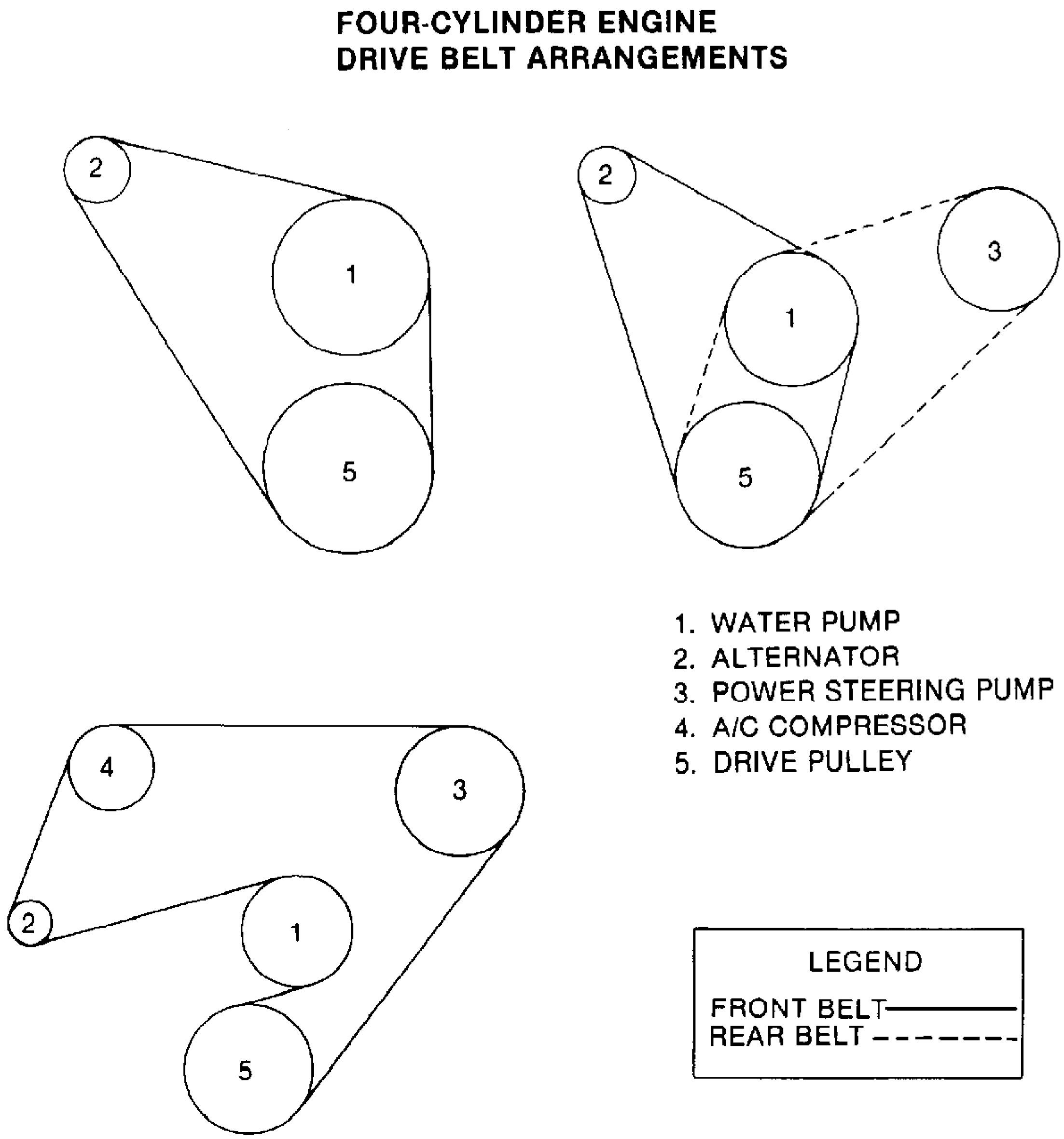


Fig. 2: Drive Belt Arrangement: 1983-88 2.5L Cherokee
Courtesy of Chrysler Motors

1983-86

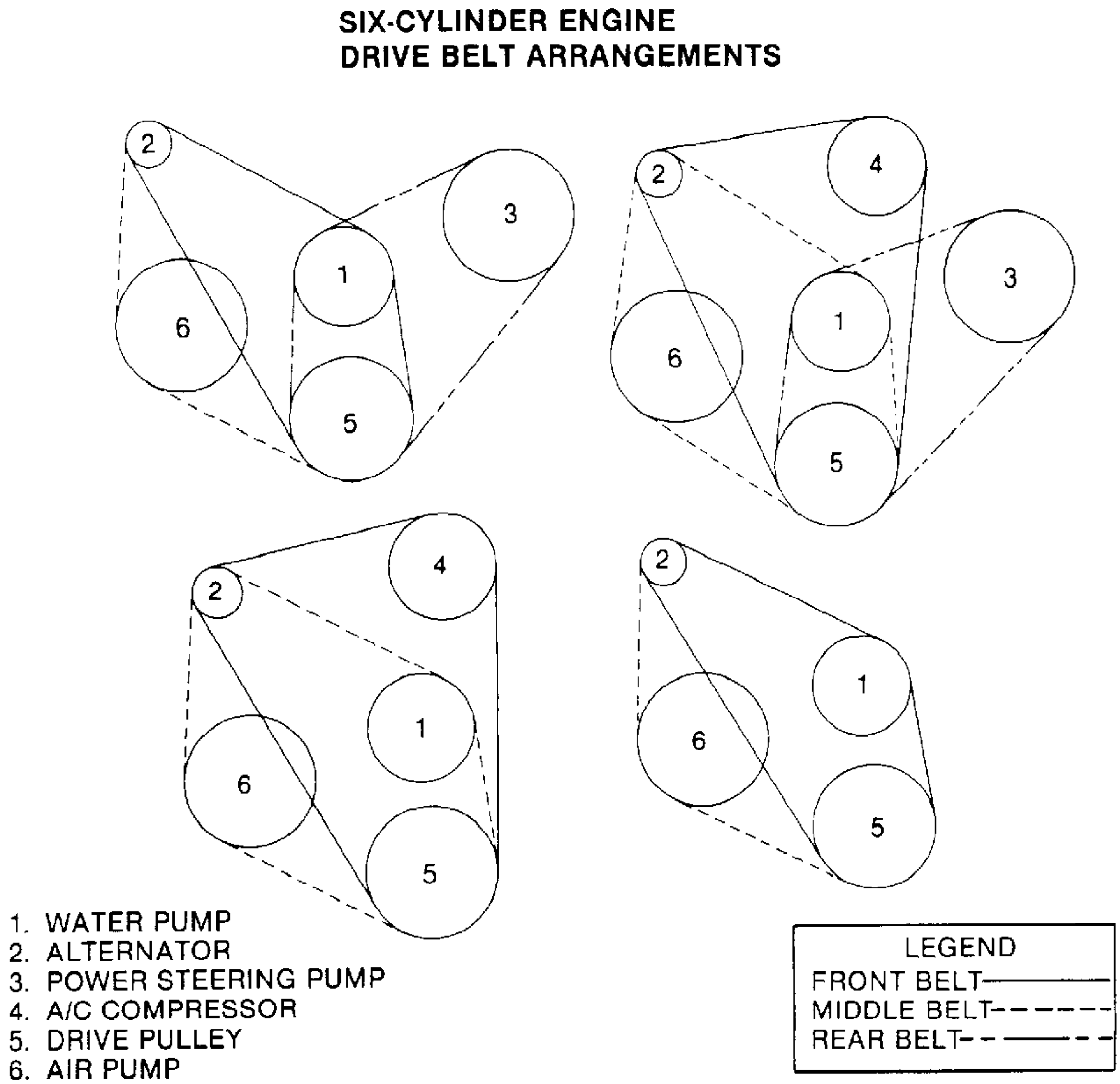


Fig. 3: Drive Belt Arrangement: 1983-86 4.2L Cherokee
Courtesy of Chrysler Motors

WRANGLER

Install belt on crankshaft and belt-driven components as shown. Adjust tensioner. See Figs. 4-10.

1983-88

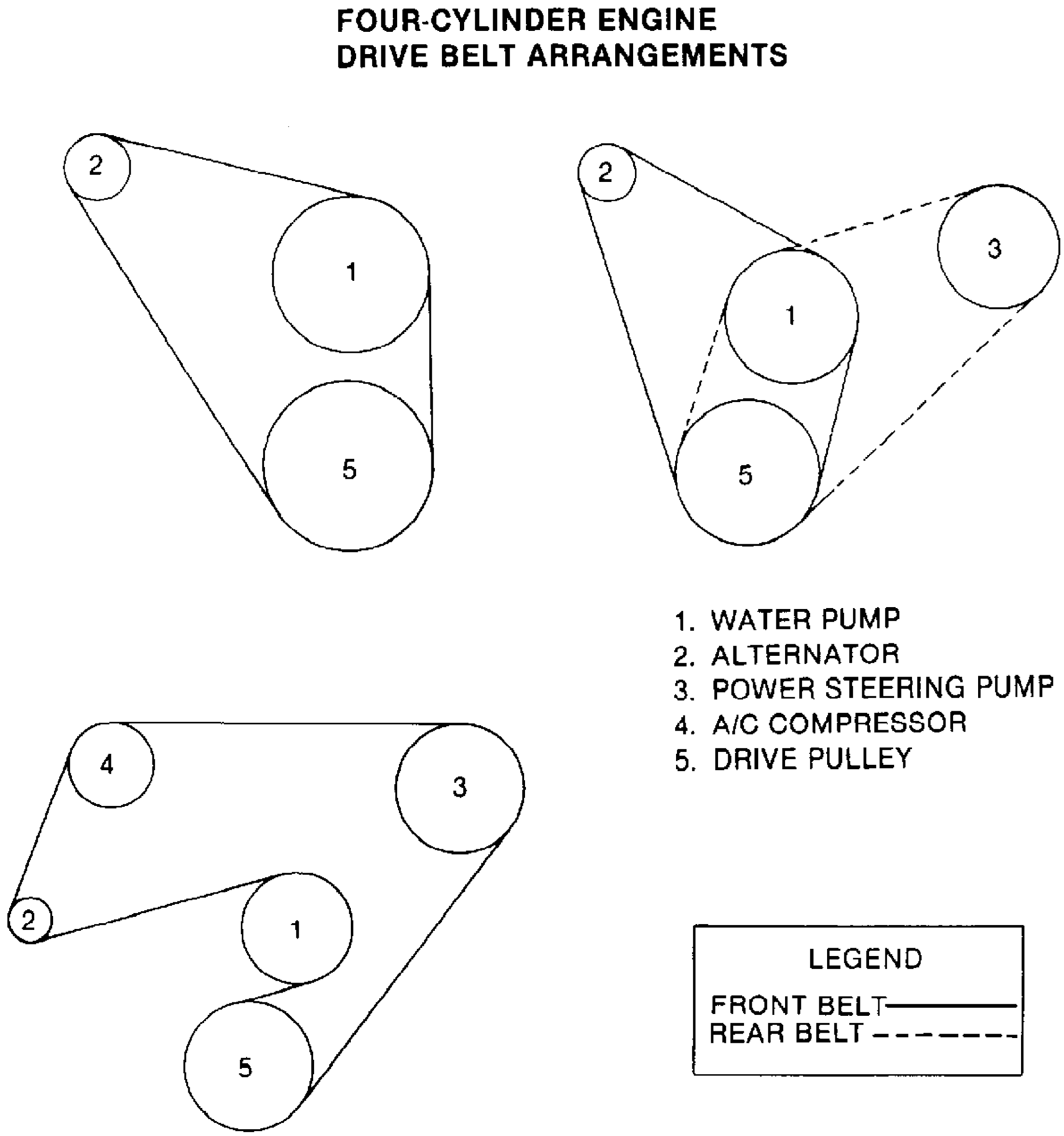


Fig. 4: Drive Belt Arrangement: 1983-88 2.5L Wrangler
Courtesy of Chrysler Motors

1983-86

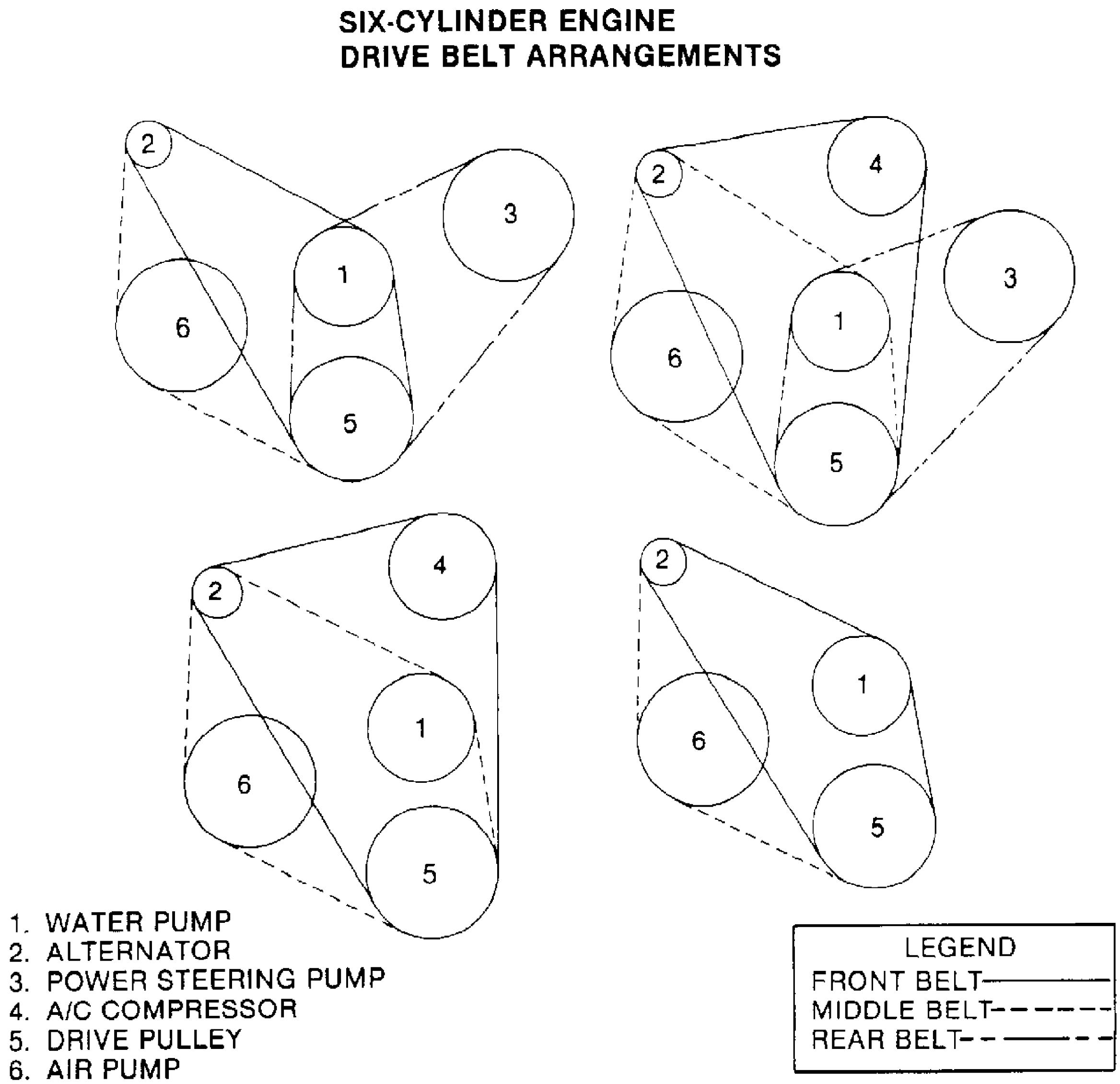


Fig. 5: Drive Belt Arrangement: 1983-86 4.2L Wrangler
Courtesy of Chrysler Motors

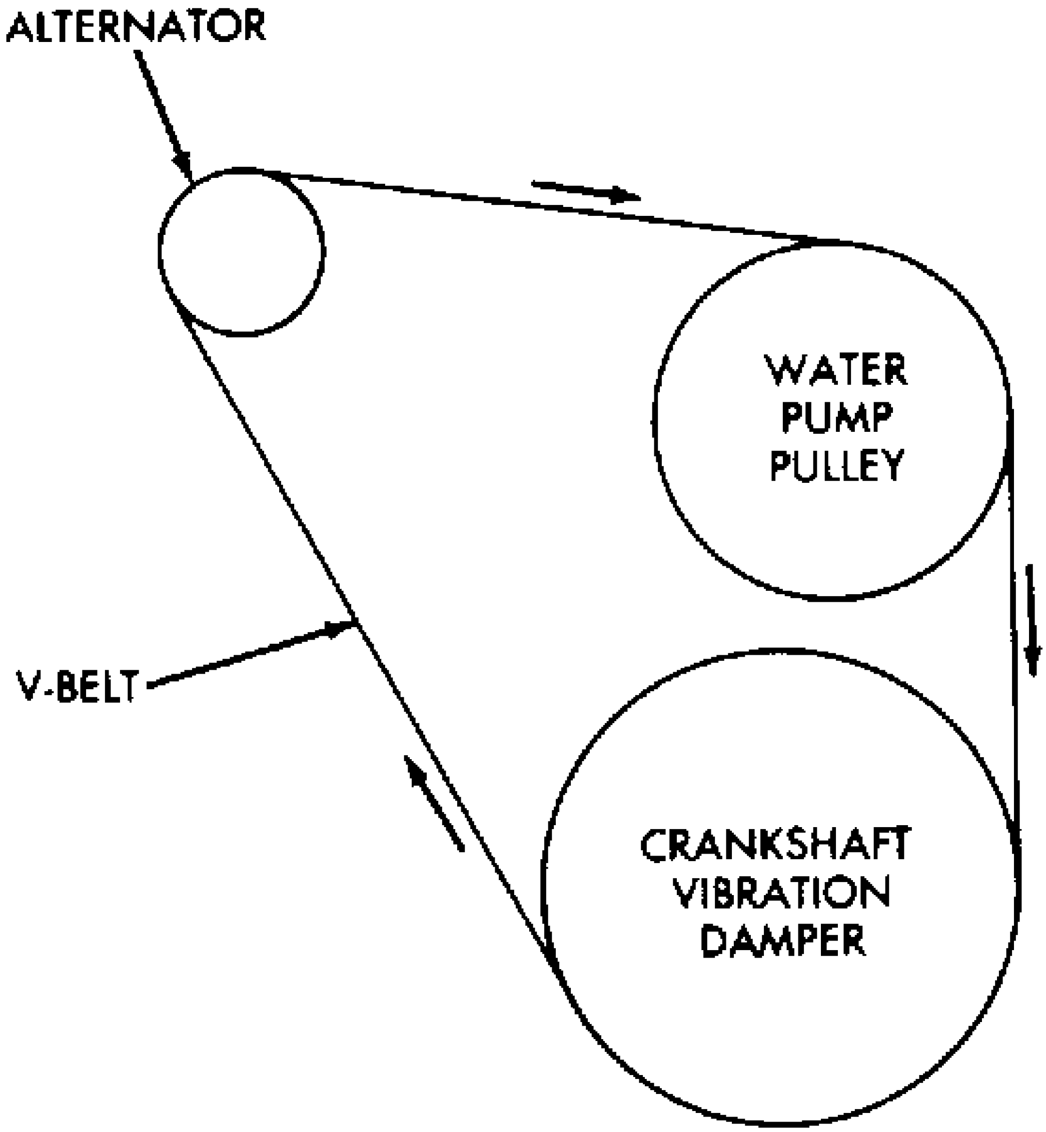


Fig. 6: Alternator Only: 1989 2.5L and 4.2L Wrangler (Except California)
Courtesy of Chrysler Motors

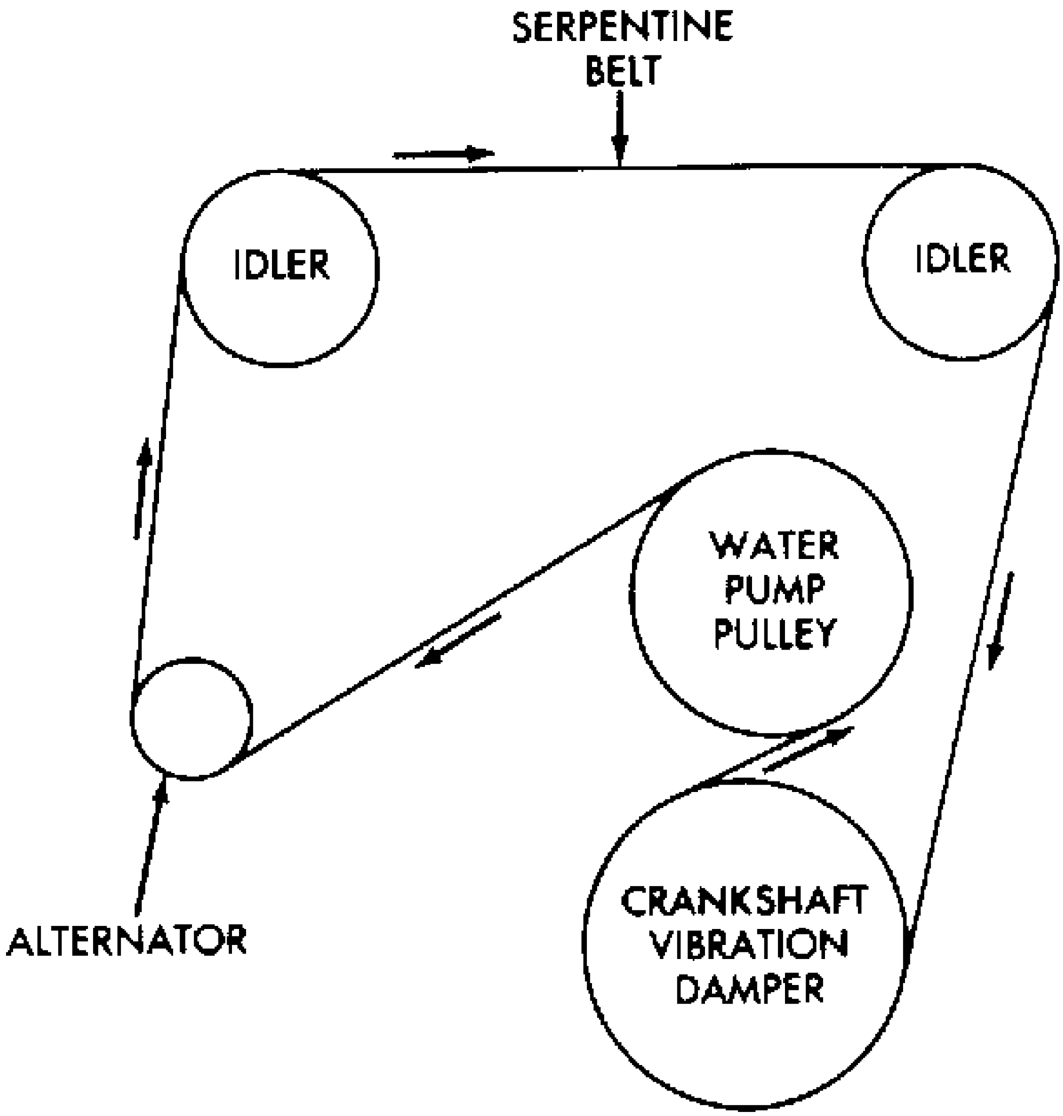


Fig. 7: Alternator Only: 1989 4.2L Wrangler (California)
Courtesy of Chrysler Motors

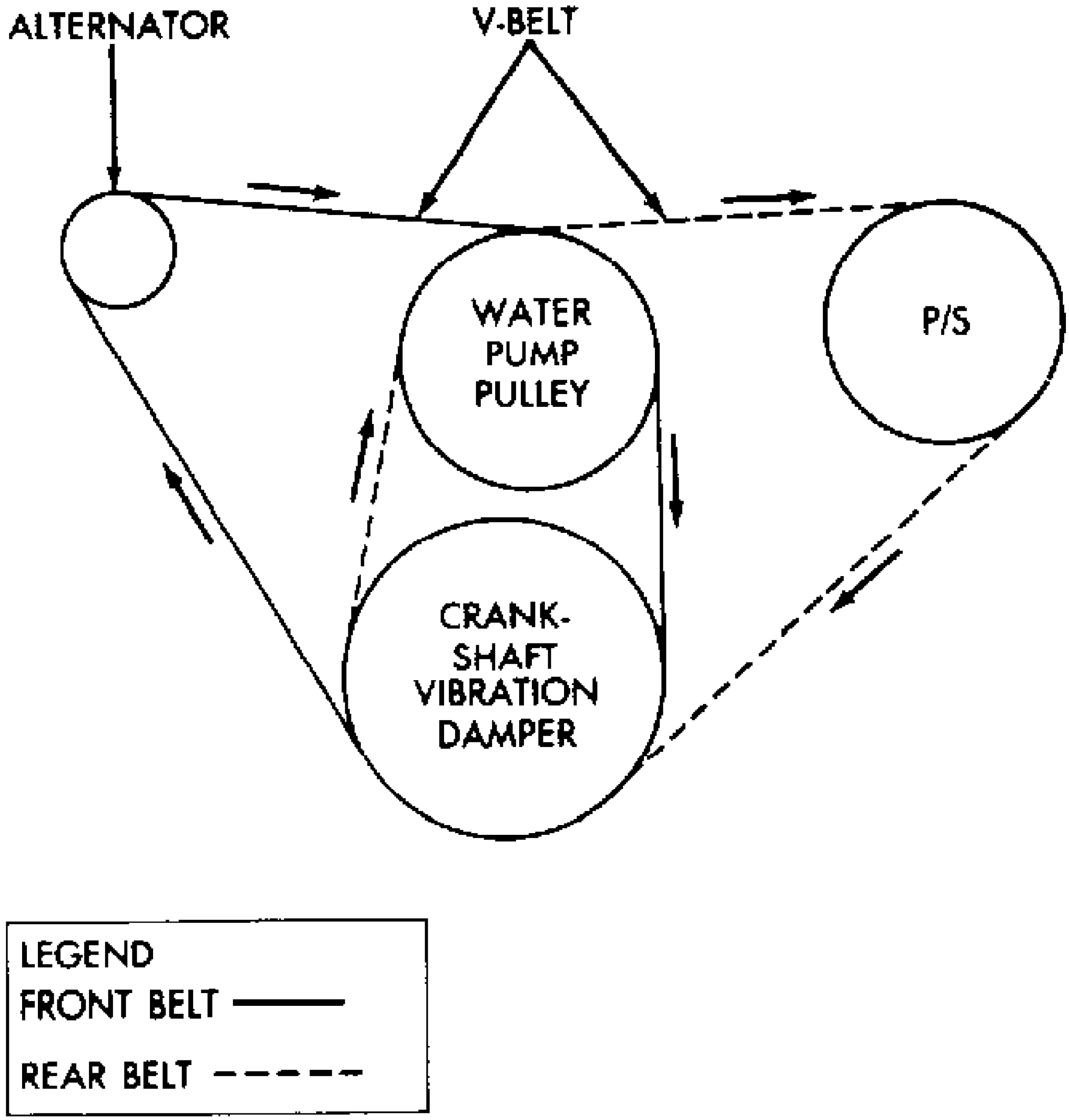


Fig. 8: Alternator & P/S: 1989 2.5L and 4.2L Wrangler (Except California)
Courtesy of Chrysler Motors

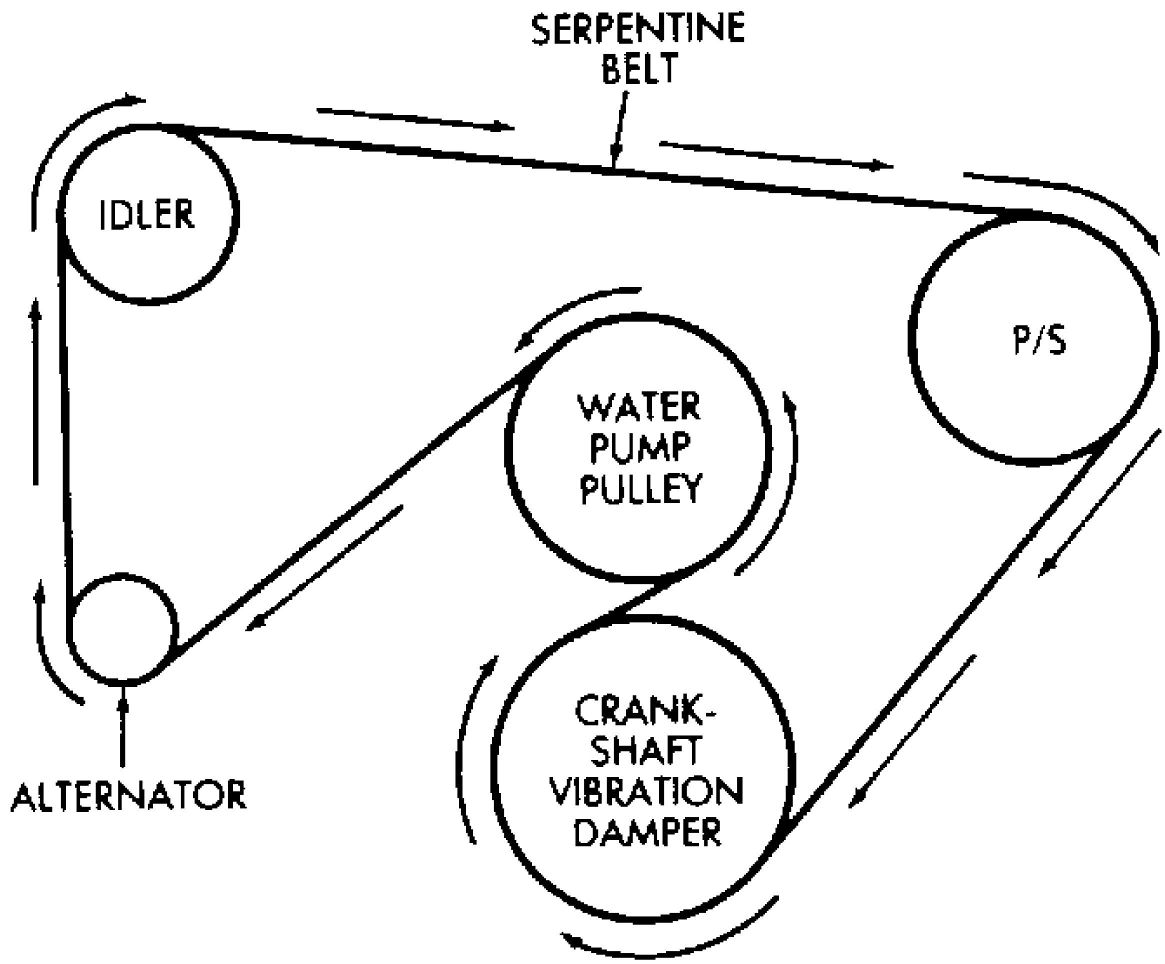


Fig. 9: Alternator & P/S: 1989 4.2L Wrangler (California)
Courtesy of Chrysler Motors

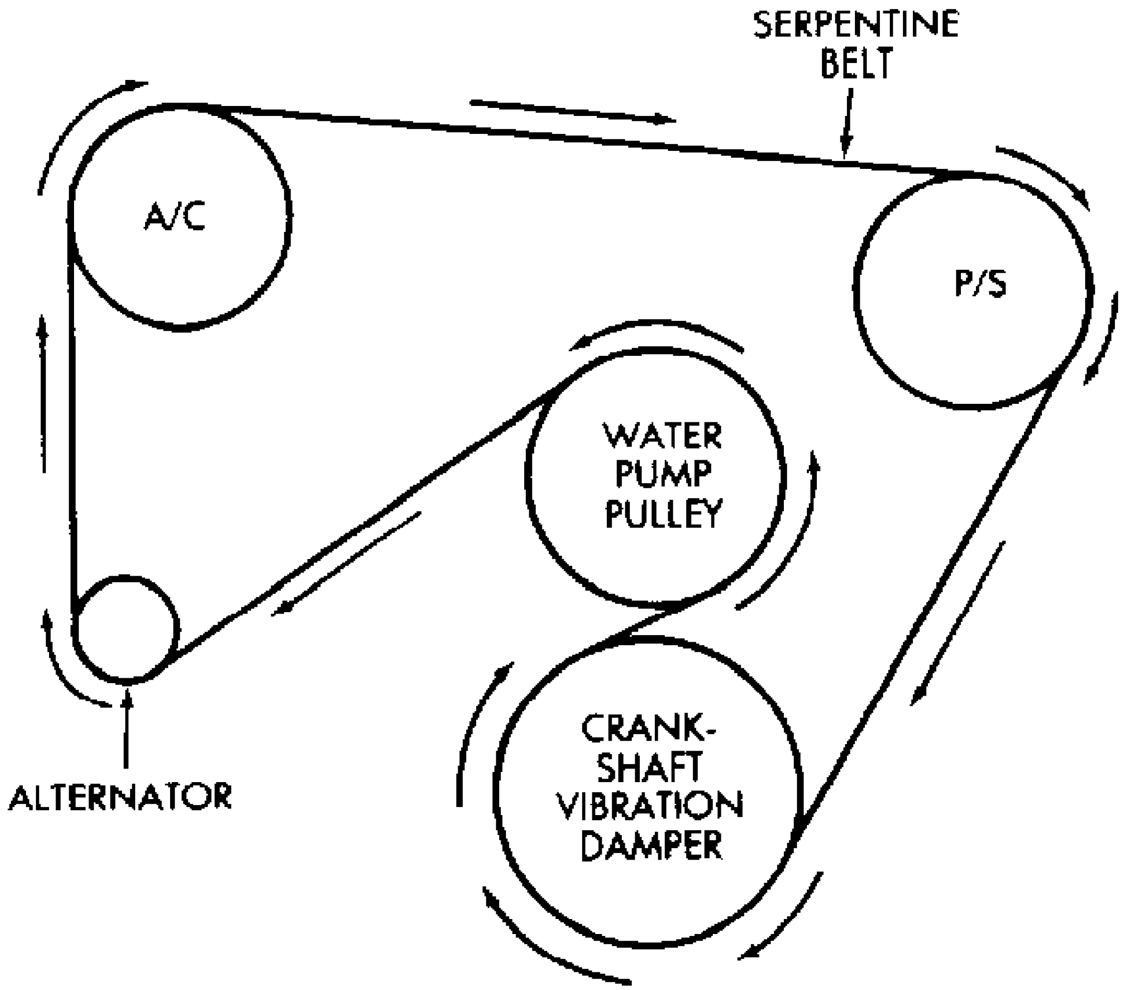


Fig. 10: Alternator, A/C & P/S: 1989 4.2L Wrangler
Courtesy of Chrysler Motors

COMANCHE AND WAGONEER

Install belt on crankshaft and belt-driven components as shown. Adjust tensioner. See Figs. 11-18.

1983-88

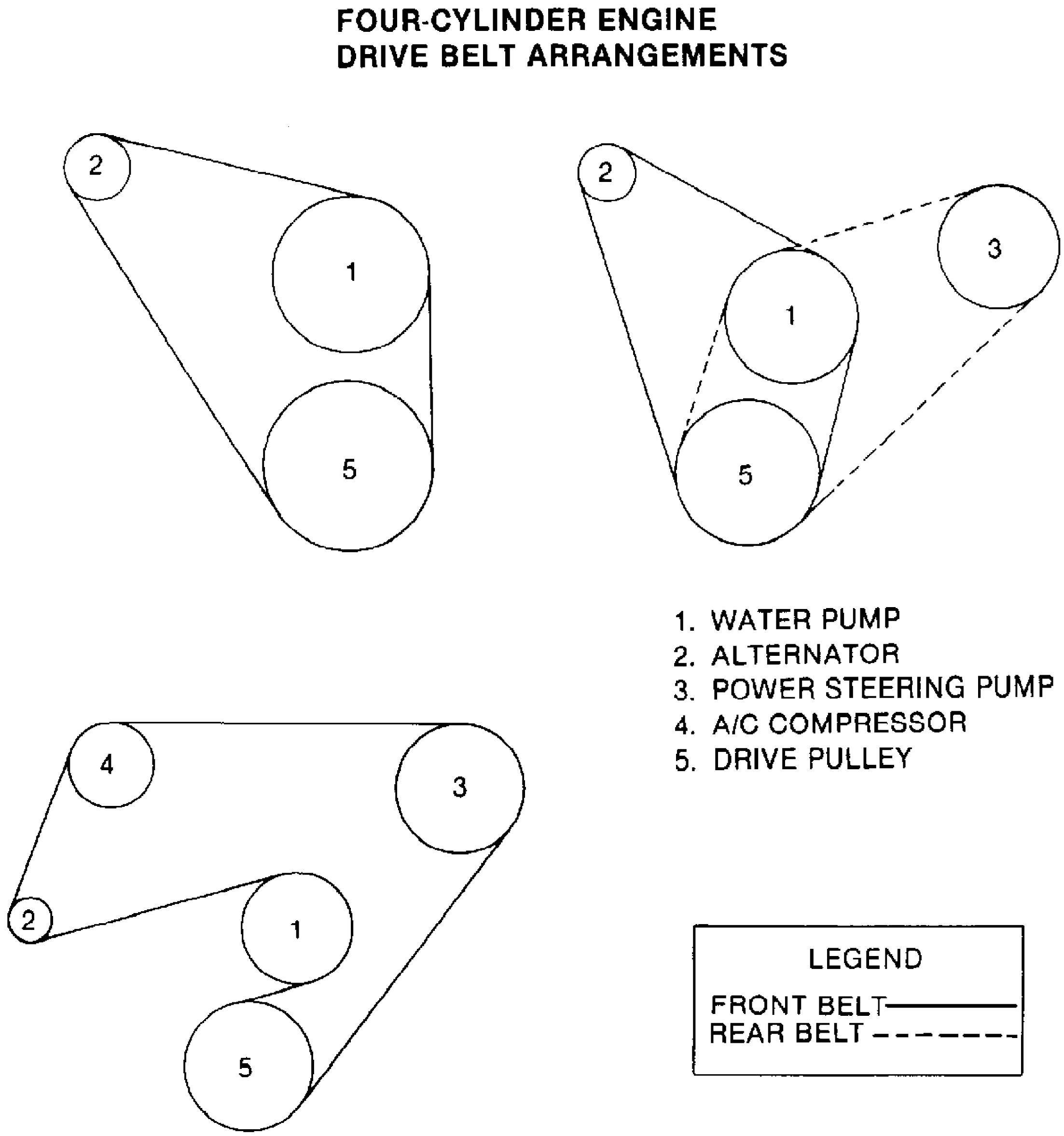


Fig. 11: Drive Belt Arrangement: 1983-88 2.5L Comanche & Wagoneer
Courtesy of Chrysler Motors

1983-86

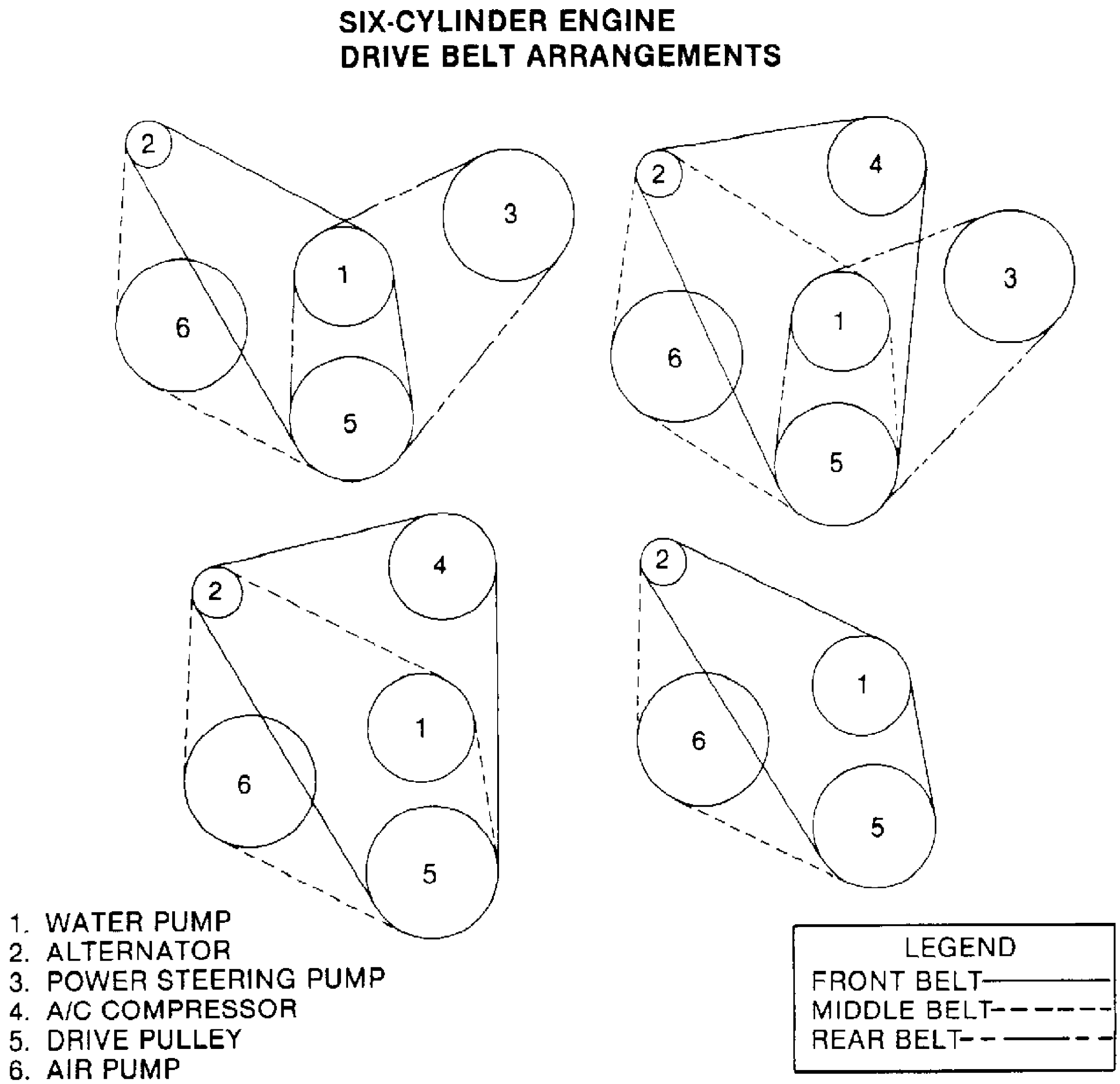


Fig. 12: Drive Belt Arrangement: 1983-86 4.2L Comanche & Wagoneer
Courtesy of Chrysler Motors

1987-89

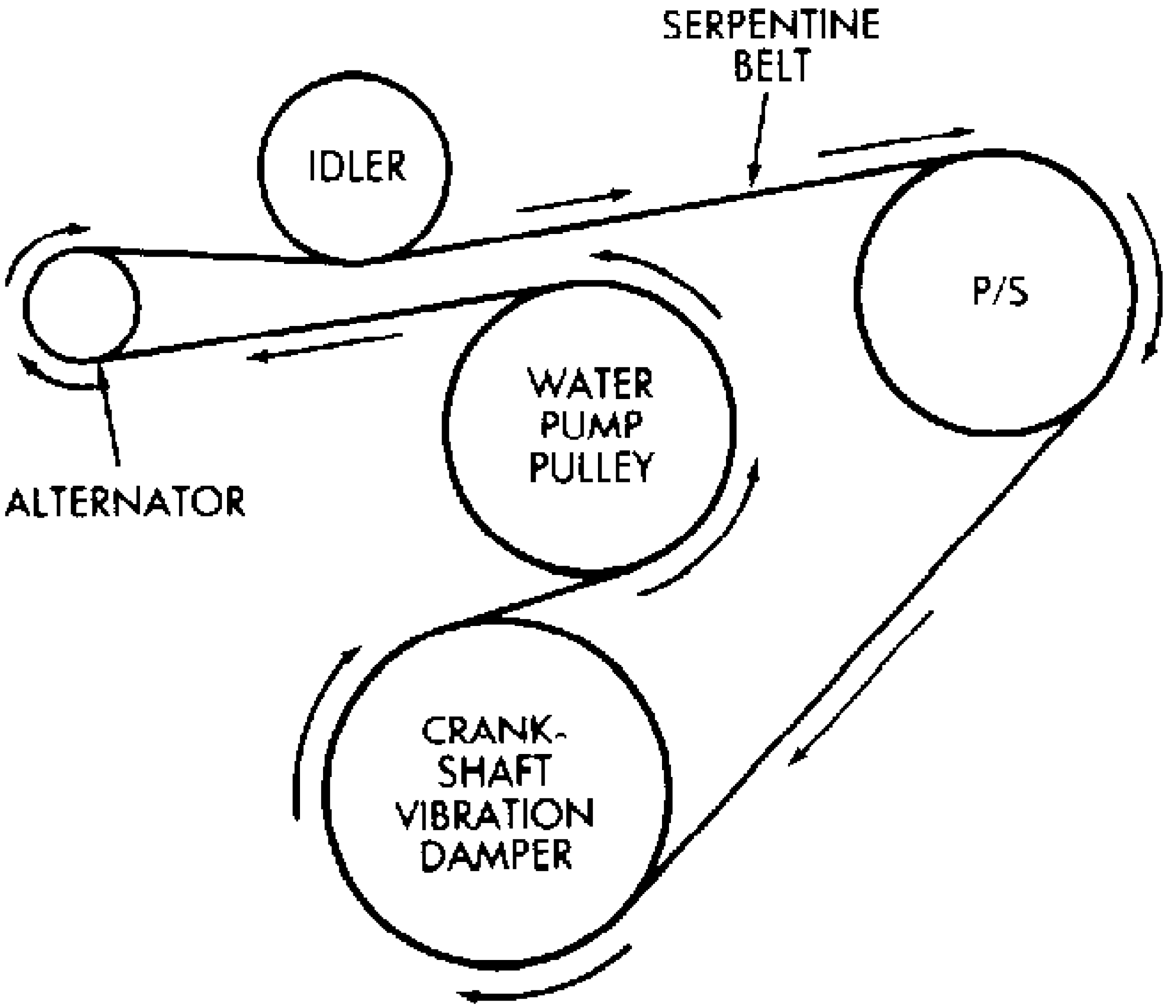


Fig. 13: Alternator & P/S: 1987-89 2.5L Comanche & Wagoneer
Courtesy of Chrysler Motors

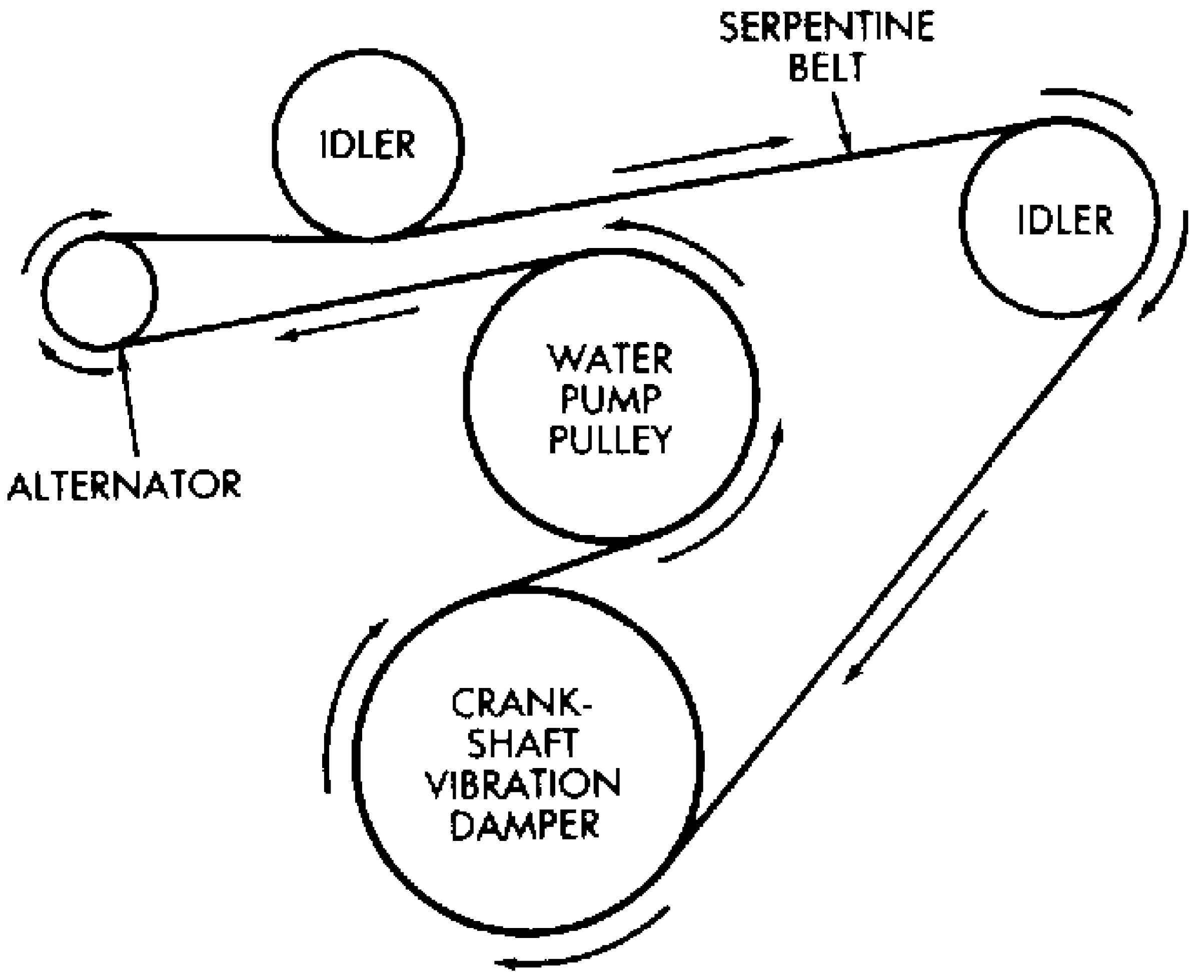


Fig. 14: Alternator Only: 1987-89 2.5L Comanche & Wagoneer
Courtesy of Chrysler Motors

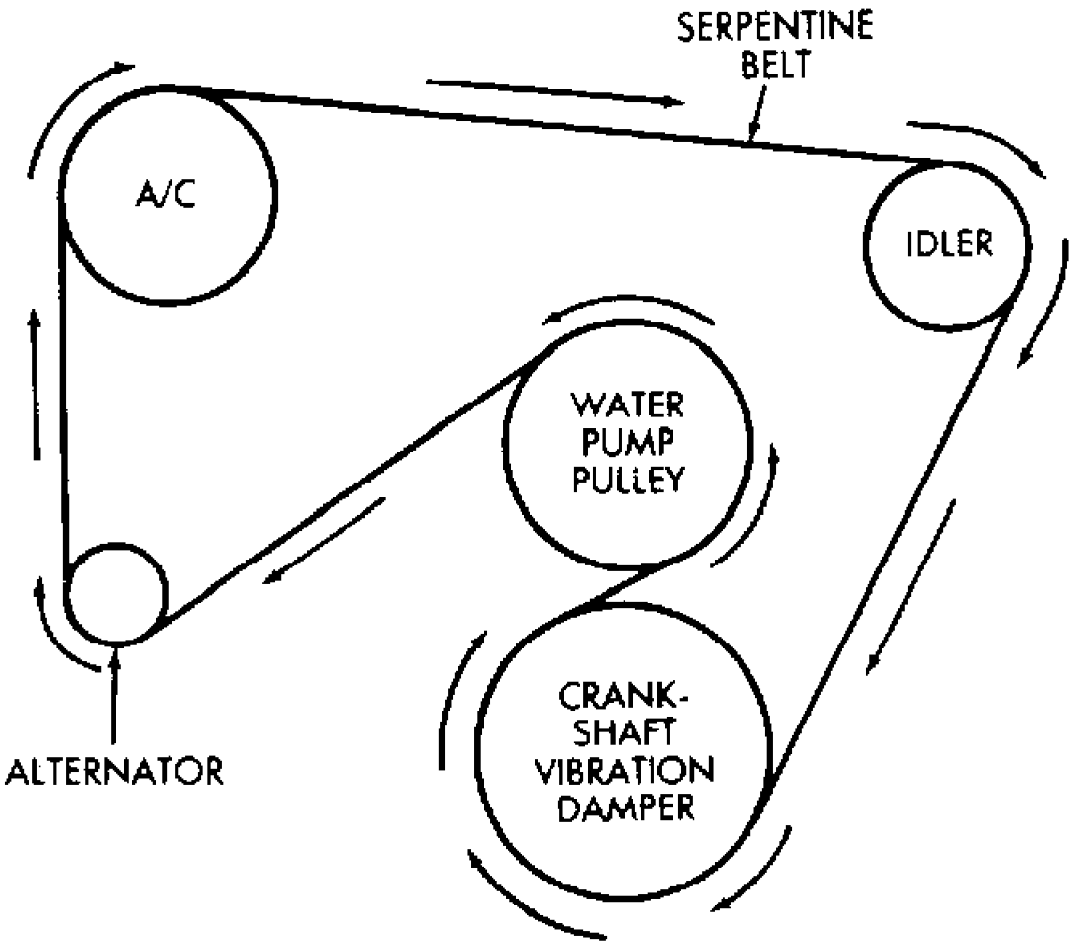


Fig. 15: Alternator & A/C: 1987-89 2.5L Comanche & Wagoneer
Courtesy of Chrysler Motors

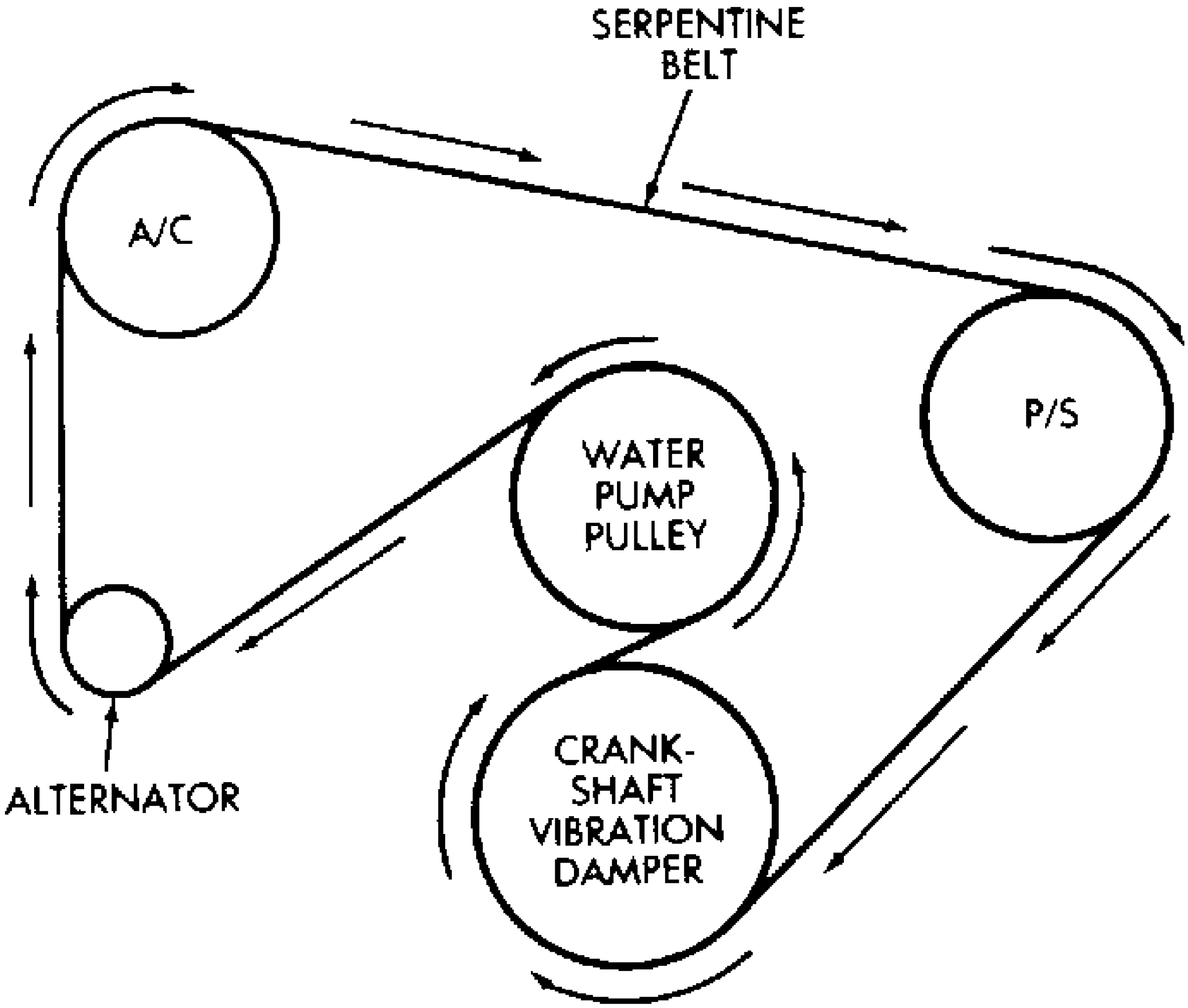


Fig. 16: Alternator, A/C & P/S: 1987-89 2.5L Comanche & Wagoneer
Courtesy of Chrysler Motors

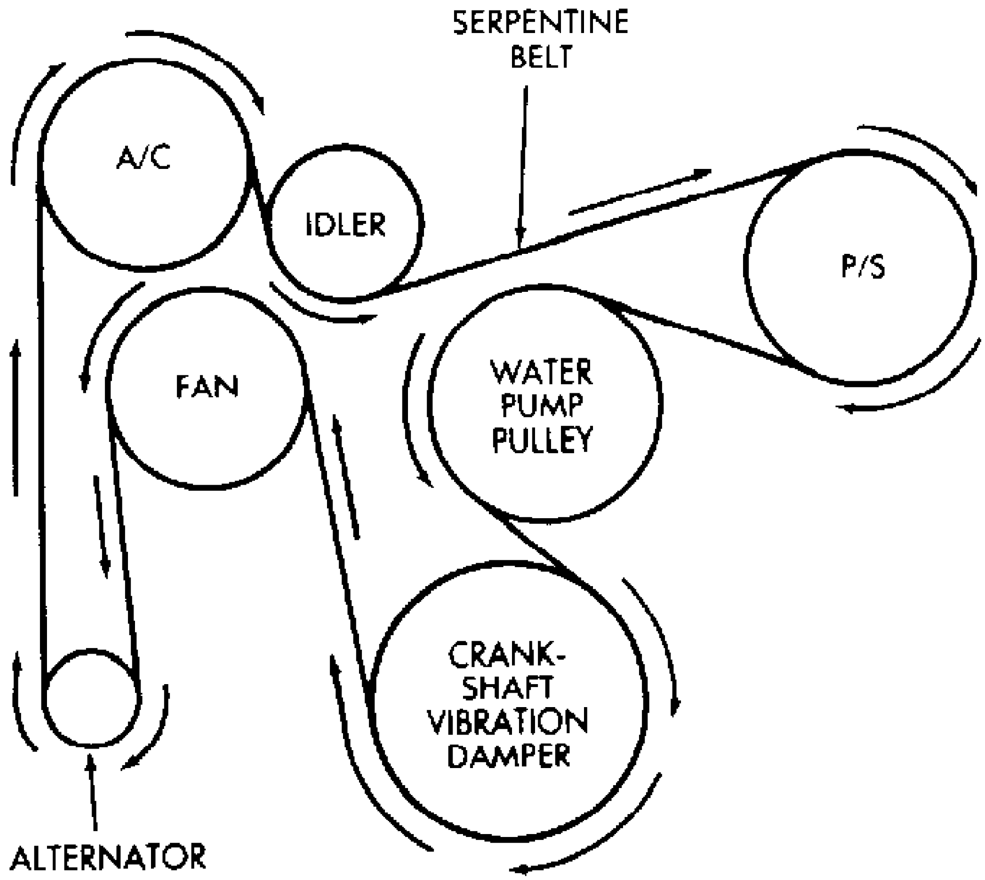


Fig. 17: Alternator, A/C & P/S: 1987-89 4.0L Comanche & Wagoneer
Courtesy of Chrysler Motors

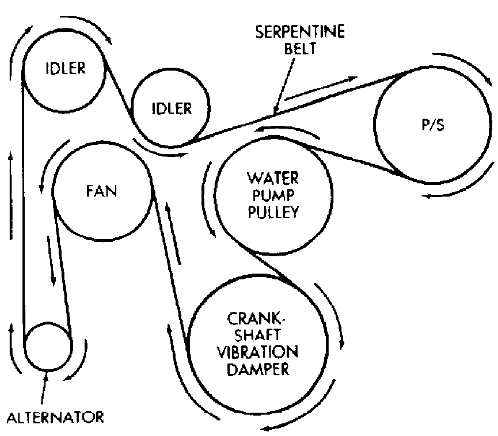


Fig. 18: Alternator & P/S: 1987-89 4.0L Comanche & Wagoneer
Courtesy of Chrysler Motors

GRAND WAGONEER

Install belt on crankshaft and belt-driven components as shown. Adjust tensioner. See Figs. 19-24.

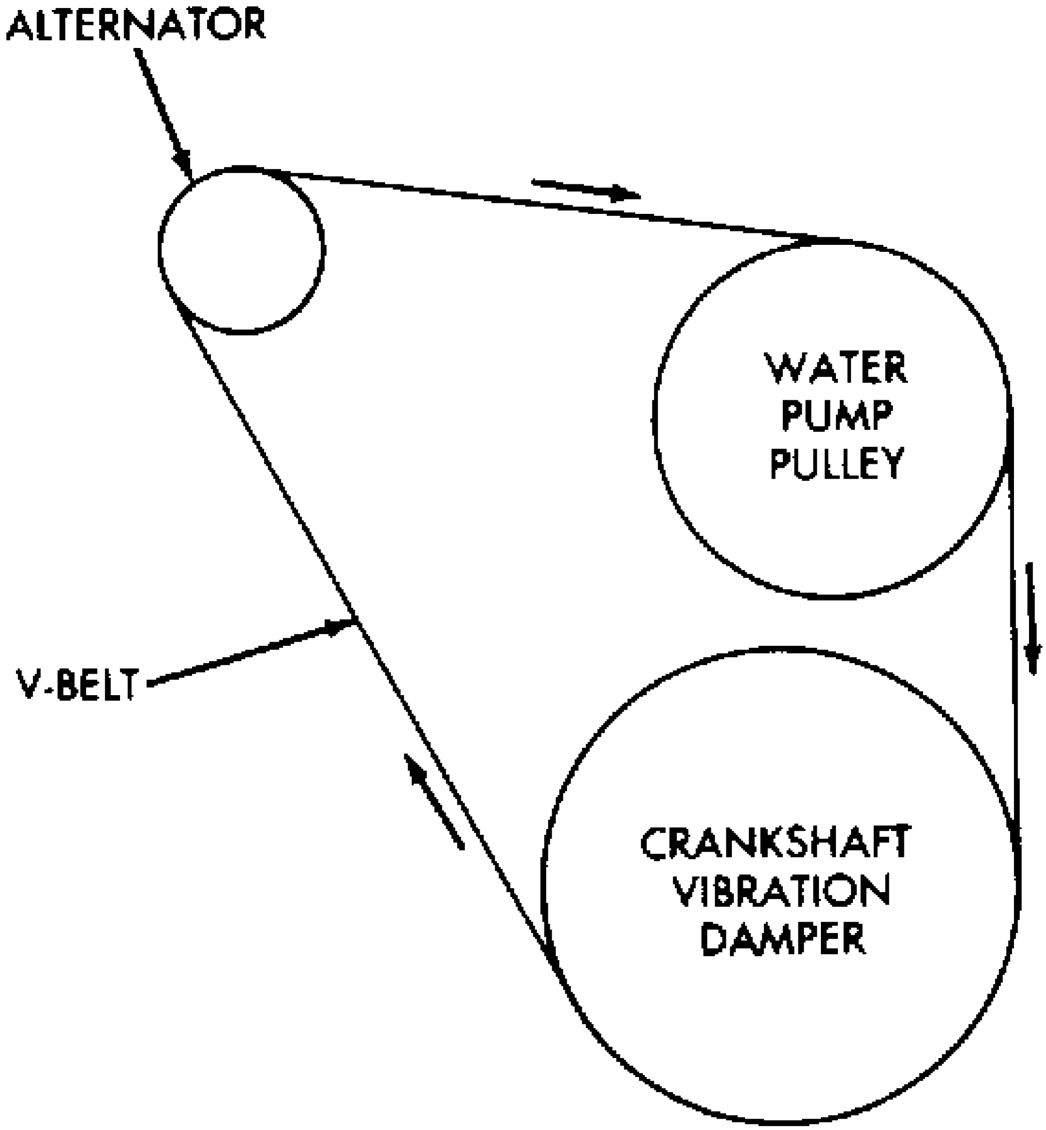


Fig. 19: Alternator Only: 4.2L Grand Wagoneer
Courtesy of Chrysler Motors

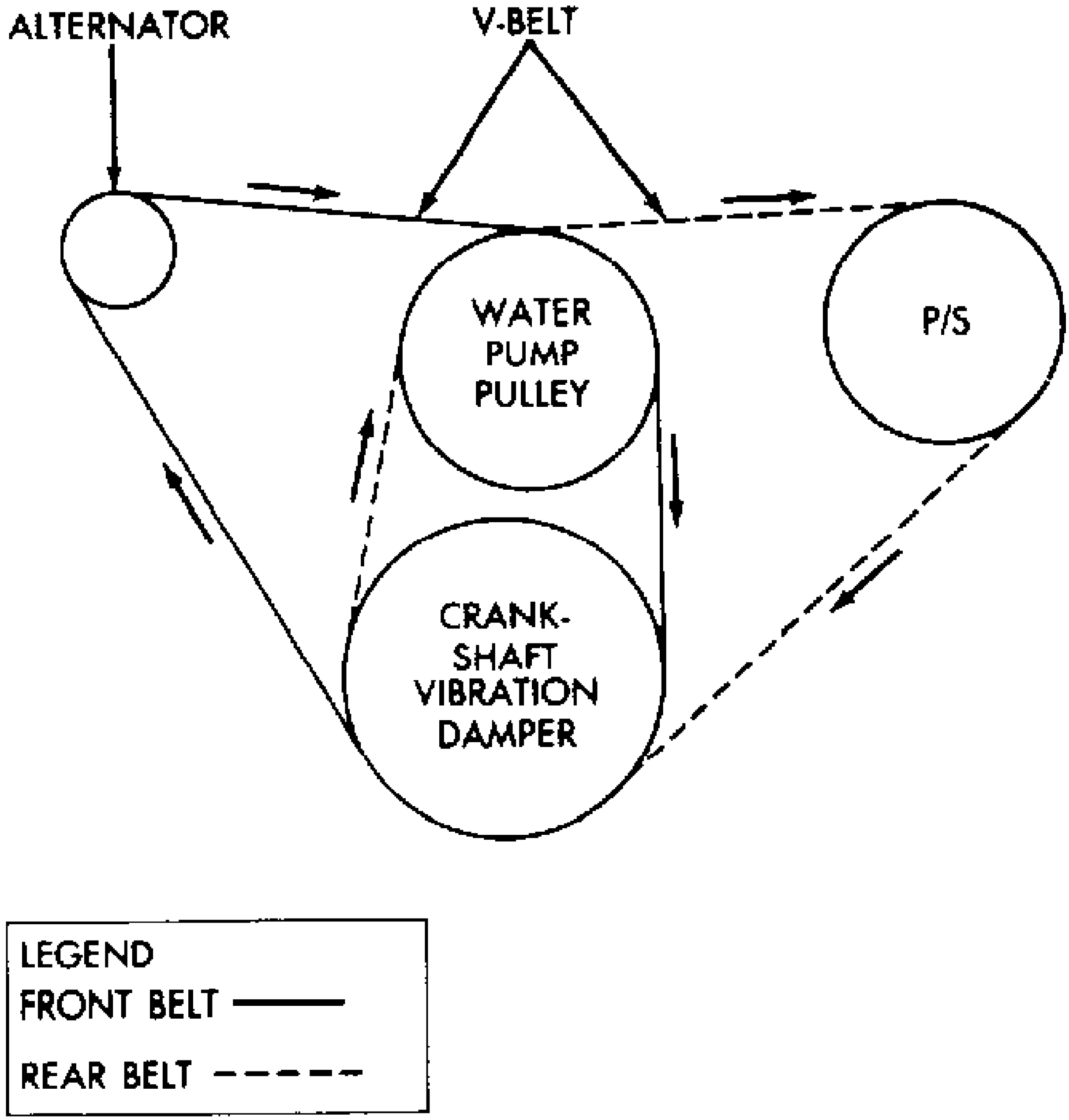


Fig. 20: Alternator, P/S: 4.2L Grand Wagoneer
Courtesy of Chrysler Motors

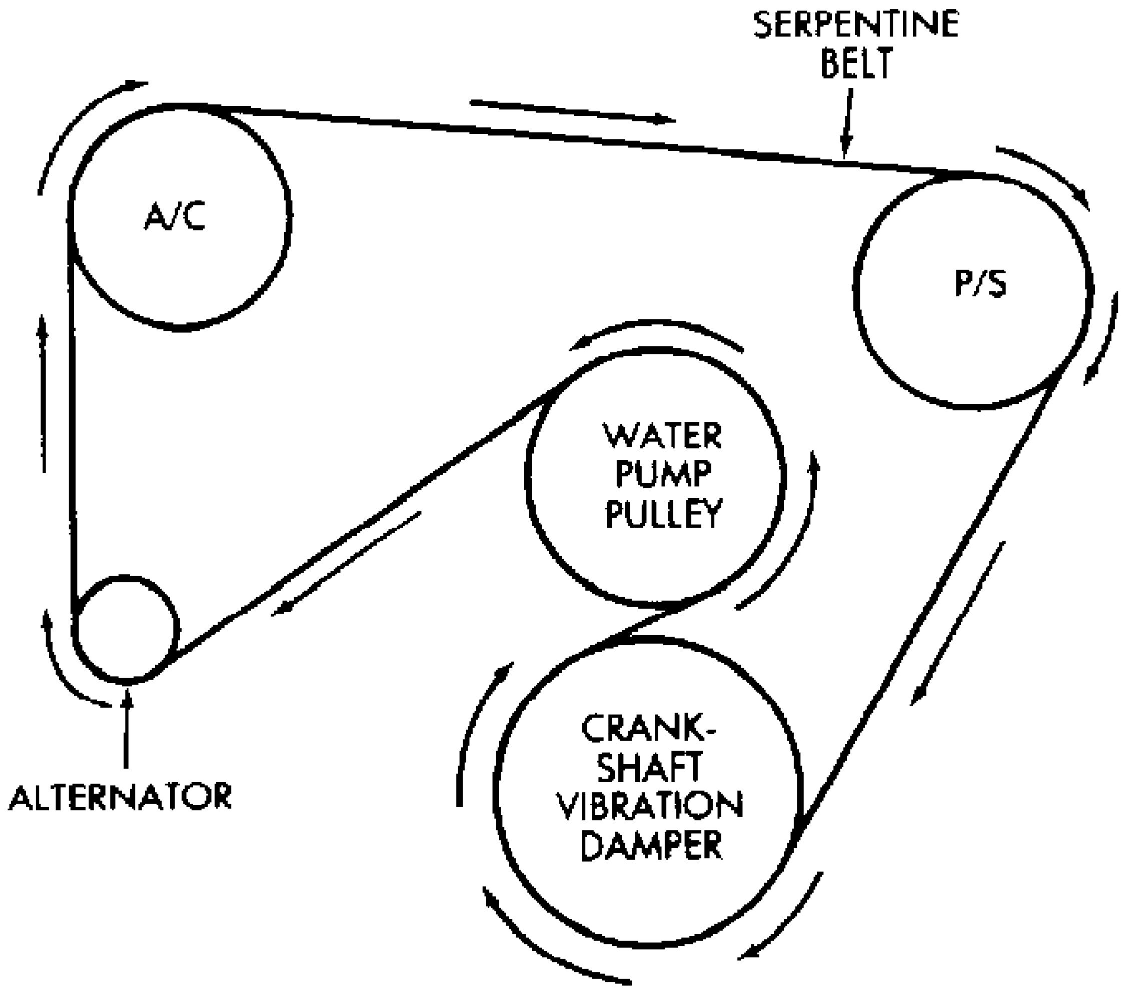


Fig. 21: Alternator W/Serpentine Belt: 4.2L Grand Wagoneer (California)
Courtesy of Chrysler Motors

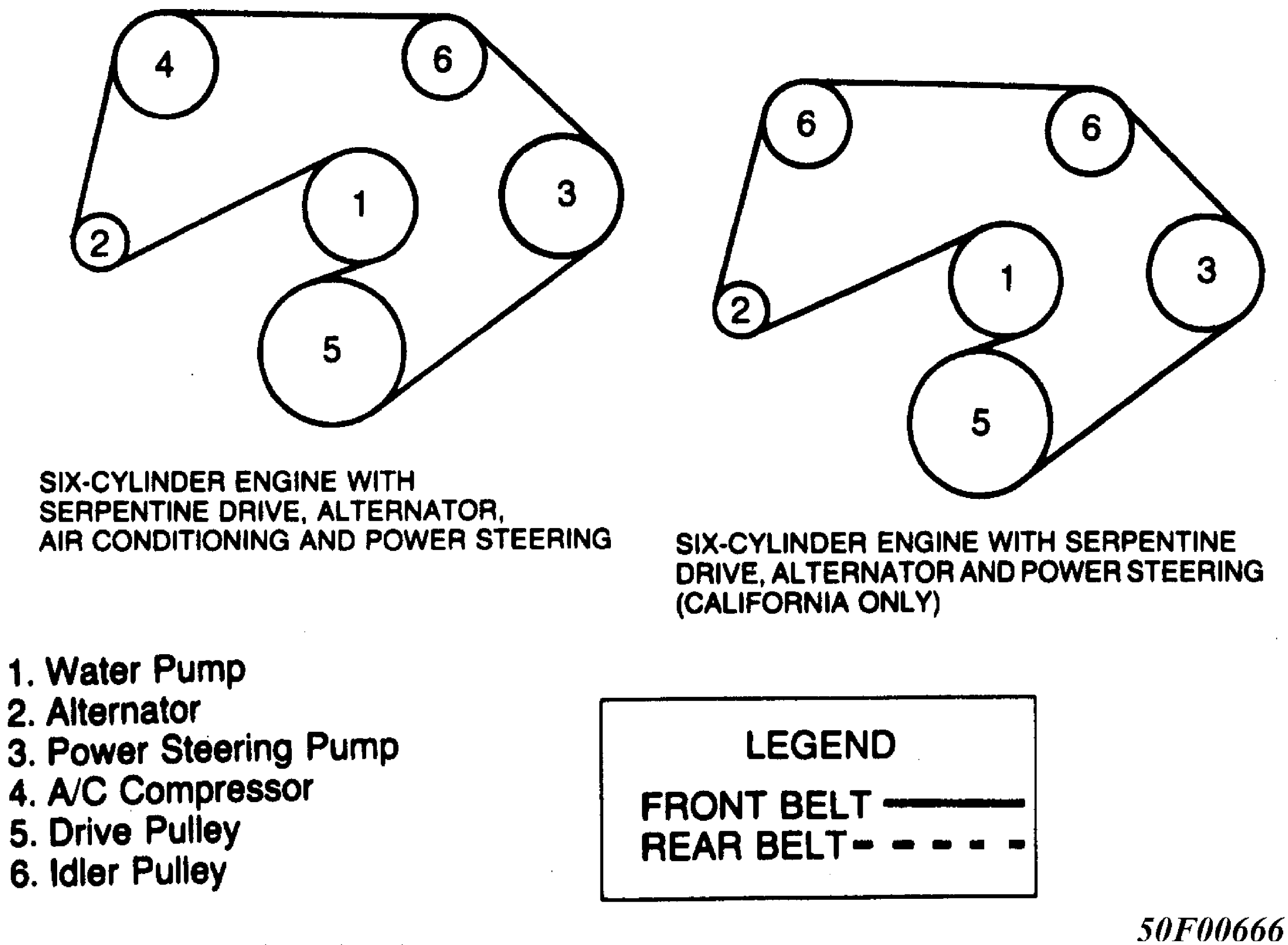


Fig. 22: Alternator, A/C, P/S W/Serpentine Belt: 4.2L Grand Wagoneer
Courtesy of Chrysler Motors

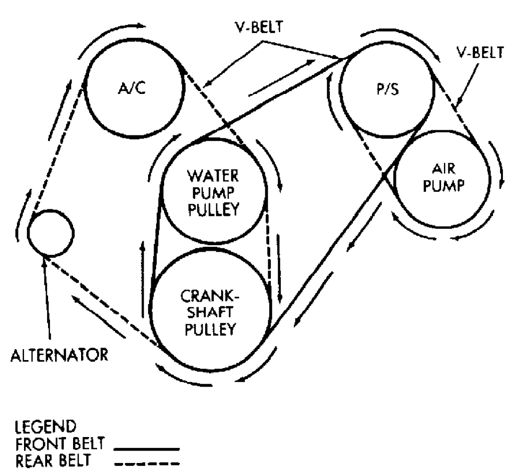


Fig. 23: Alternator, A/C, Air Pump & P/S: 5.9L Grand Wagoneer
Courtesy of Chrysler Motors

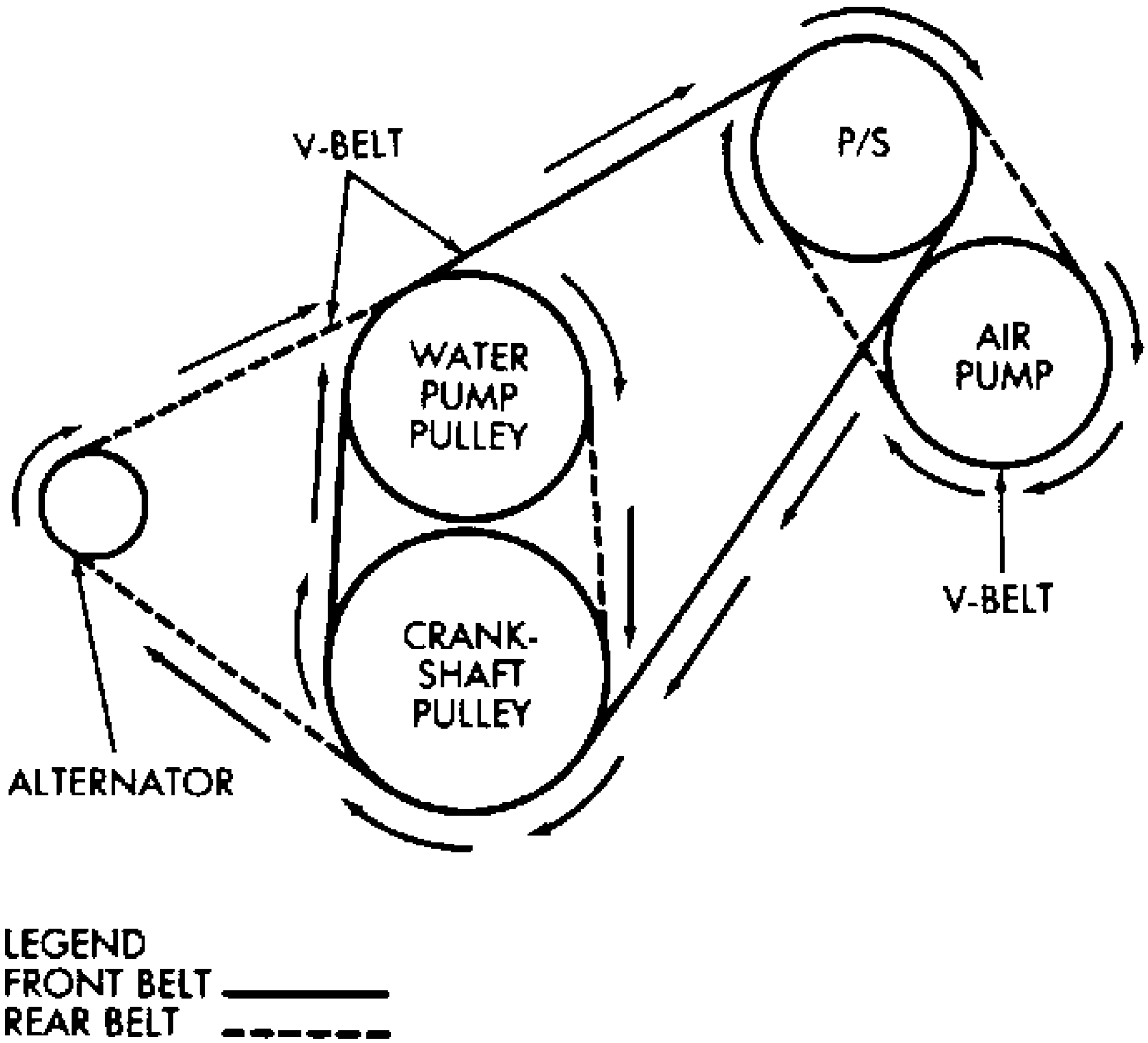


Fig. 24: Alternator, Air Pump & P/S: 5.9L Grand Wagoneer
Courtesy of Chrysler Motors

BELT TENSION TABLE

Application	New Belt (1)	Used Belt (1)
All Engines	180-200 (82 - 90)	140-160 (63-72)

(1) - Tension in Lbs. (Kg) Using Strand Tension Gauge

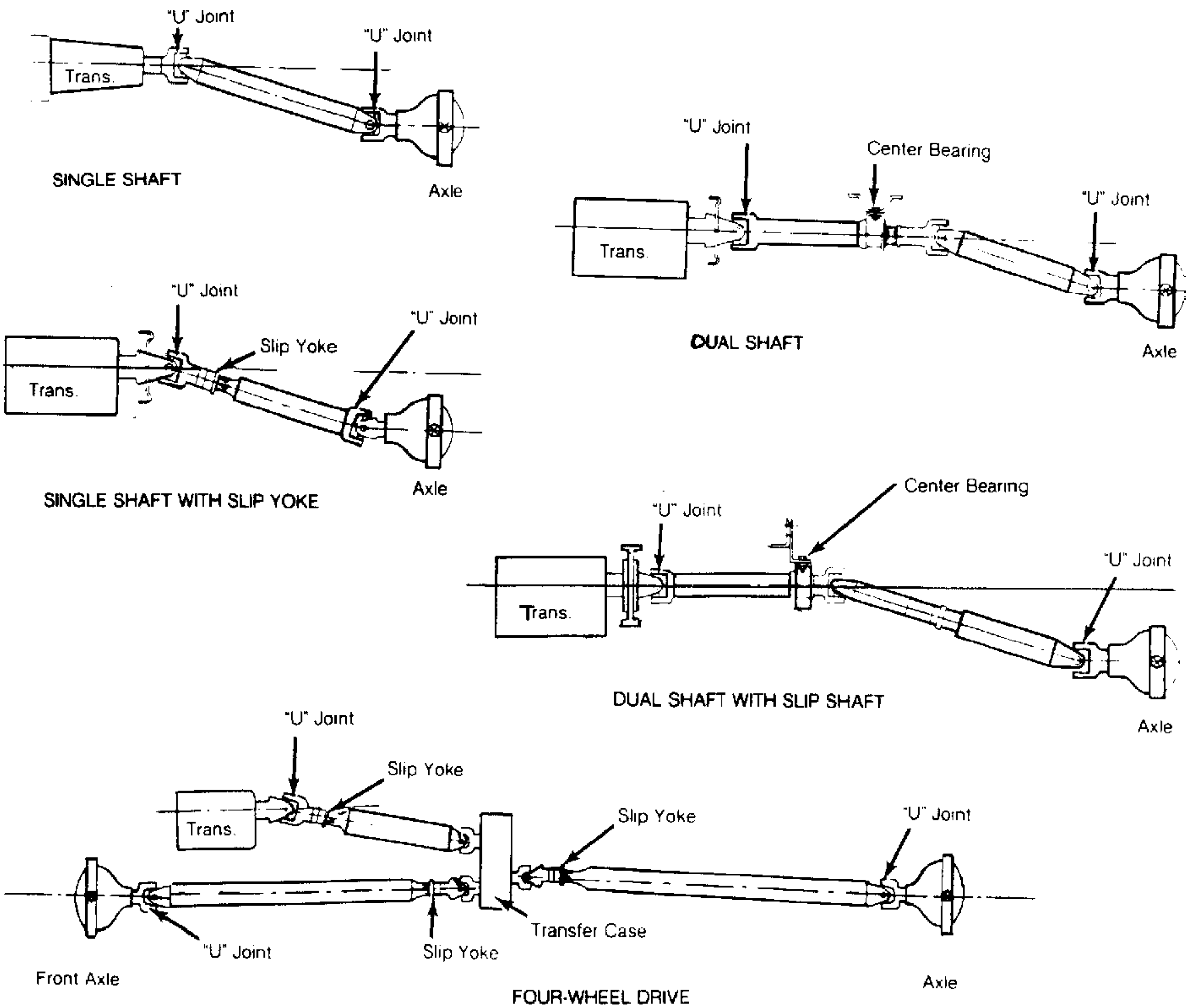
DRIVE SHAFT ALIGNMENT

1988 Jeep Cherokee

1988 Drive Shafts Alignment

DESCRIPTION

Drive shafts are balanced, one-piece, tubular shafts with universal joints at each end. Number used in vehicle varies: one shaft, 2 shafts with a center bearing, or 3 shafts. Three shafts are used in many 4WD applications. Location of slip joints varies with model and manufacturer. See Fig. 1.



28874
Fig. 1: View of 5 Commonly Used Drive Shaft Combinations
Many 4WD models use 3 drive shafts.

INSPECTION

Vibration can come from many sources. Before overhauling driveline, check other sources of possible vibration as follows:

* Tires and wheels - Check tire inflation and wheel balance. Check for foreign objects in tread, damaged tread, mismatched tread patterns or incorrect tire size.
* Center Bearing - Tighten drive shaft center bearing mounting bolts. If bearing insulator is deteriorated or oil-soaked, replace it.
* Engine & Transmission Mountings - Tighten mounting bolts. If mountings are deteriorated, replace them.
* Drive Shaft - Check drive shaft for damage or dents that could affect balance. Check for undercoating adhering to shafts. If present, clean shafts thoroughly.
* Universal Joints - Check for foreign material stuck in joints. Check for loose bolts and worn bearings.

ADJUSTMENTS

DRIVE SHAFT PHASING

One-Piece Shafts

Check that flanges on either end of drive shaft are in same plane. Often there are arrows on slip joint and drive shaft to aid in alignment. See Fig. 2. If flanges are not in same plane, disassemble universal joint and align.

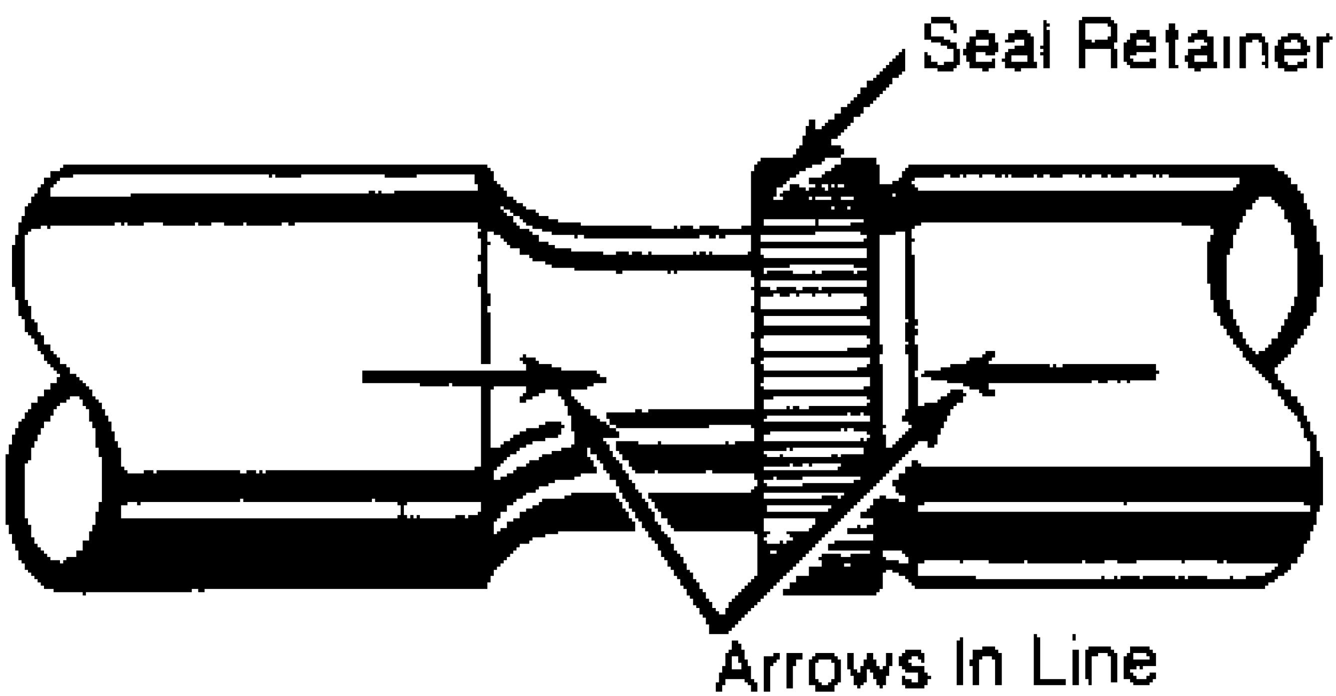


Fig. 2: Slip Joint Alignment Arrows
Align arrows for proper shaft phasing.

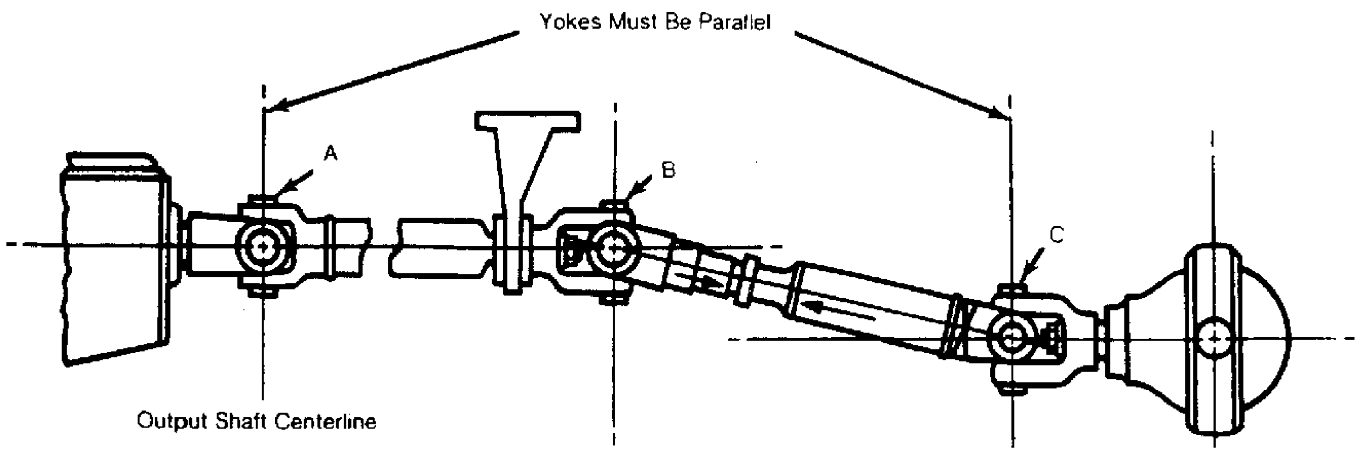
2-Piece Shafts

1) All General Motors models with 32 splines use keys on spline and slip joint, which can only mate in correct position. On most models with 2-piece shafts, proper phasing is accomplished by keys on spline and slip joint.

2) On models with 2-piece shafts, rotate transmission yoke until trunnion is in horizontal plane. Install front drive shaft with "U" joint trunnion in vertical plane. Connect bearing support to crossmember.

3) Ensure that front face of bearing support is perpendicular (90 degrees) to centerline of drive shaft. Install rear drive shaft with "U" joint trunnion of slip joint in vertical plane.

4) Set differential pinion yoke trunnion in vertical plane. Connect rear drive shaft to pinion yoke. If 2-piece shaft is correctly installed, centerline of trunnions at each end of individual shafts will be parallel. See Fig. 3.



28880
Fig. 3: Phase Alignment Of 2-Piece Drive Shafts
Trunnion yoke ears on each shaft must be parallel.

DRIVE SHAFT BALANCE TEST

1) Drive shaft imbalance may often be cured by disconnecting shaft and rotating it 180 degrees in relation to other components. Test by raising rear wheels off ground, and turning shaft with engine.

NOTE: DO NOT run engine without ram airflow across radiator for prolonged periods, as overheating of engine or transmission may occur.

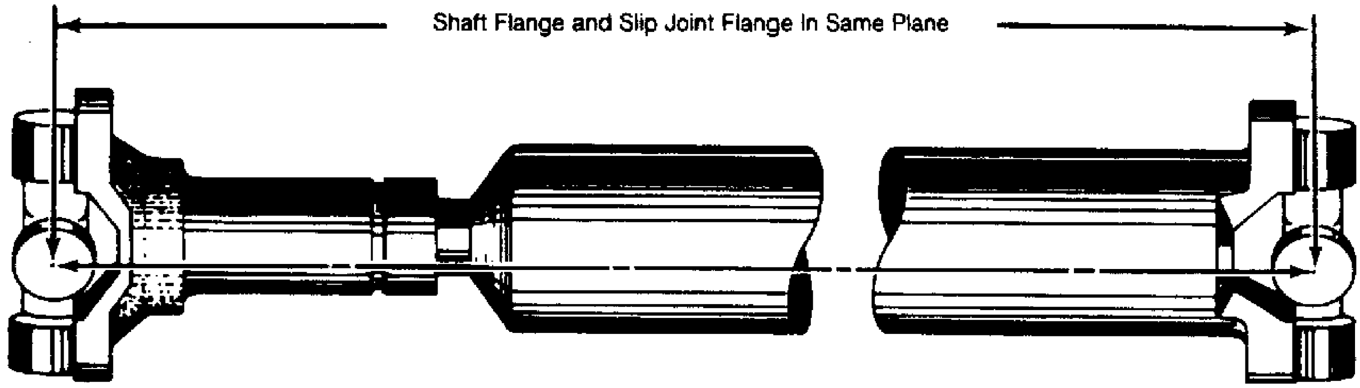
2) On most models, balance testing may be done by marking shaft in 4 positions, 90 degrees apart. Place marks approximately 6" forward of weld, at rear end of shaft. Number marks one through 4.

3) Place screw-type hose clamp so clamp head is in number one position, and rotate shaft with engine. If there is little or no change, move clamp head to No. 2 position, and repeat test.

4) Continue procedure until vibration is at lowest level. If no difference is noted with clamp head moved to all 4 positions, vibrations may not be drive shaft imbalance.

5) If vibration is lessened but not completely gone, place 2 clamps at that point, and run test again. Combined weight of clamps in one position may increase vibration. If so, rotate clamps 1/2" apart, above and below best position, and repeat test.

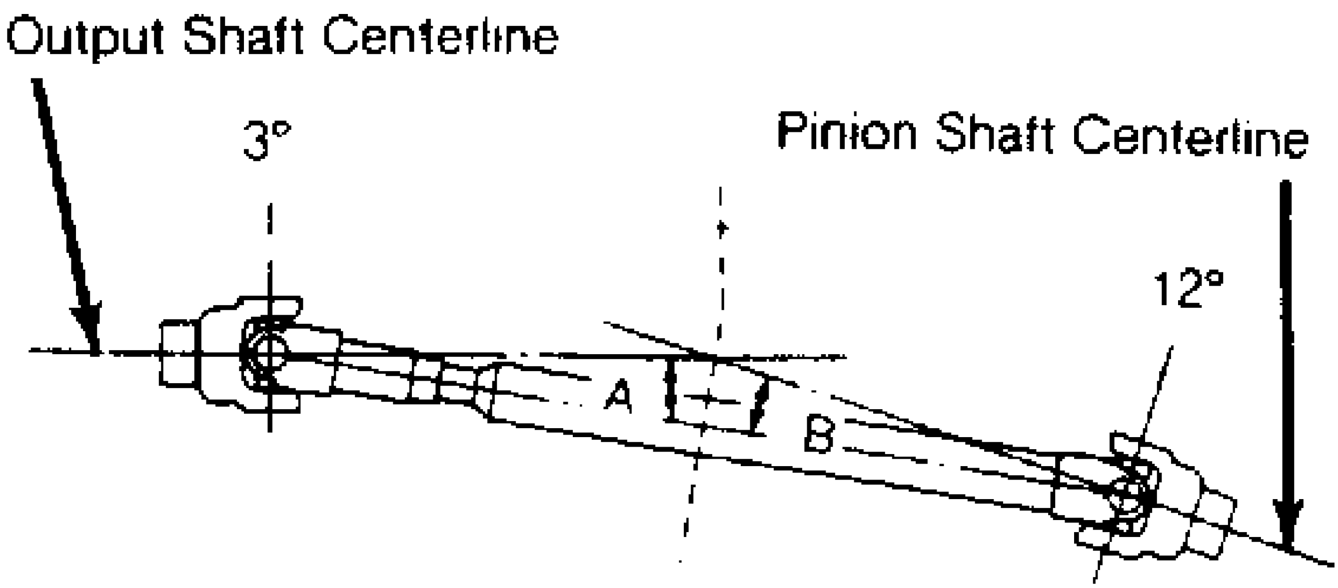
6) Continue to rotate clamps as necessary, until vibration is at lowest point. If vibration level is still unacceptable, leave rear clamp(s) in position and repeat procedure at front end of drive shaft. If vibration can be eliminated or reduced to acceptable levels using this test procedure, send drive shaft out to be balanced.



28877
Fig. 4: Drive Shaft Phase Alignment
Align drive shaft and slip joint trunnions in same plane.

FLANGE ALIGNMENT & RUNOUT

1) All flanges must be perpendicular in both vertical and horizontal planes to engine crankshaft. Only exception is "broken back" type driveline, which has flanges that are not perpendicular in vertical plane. See Fig. 5.

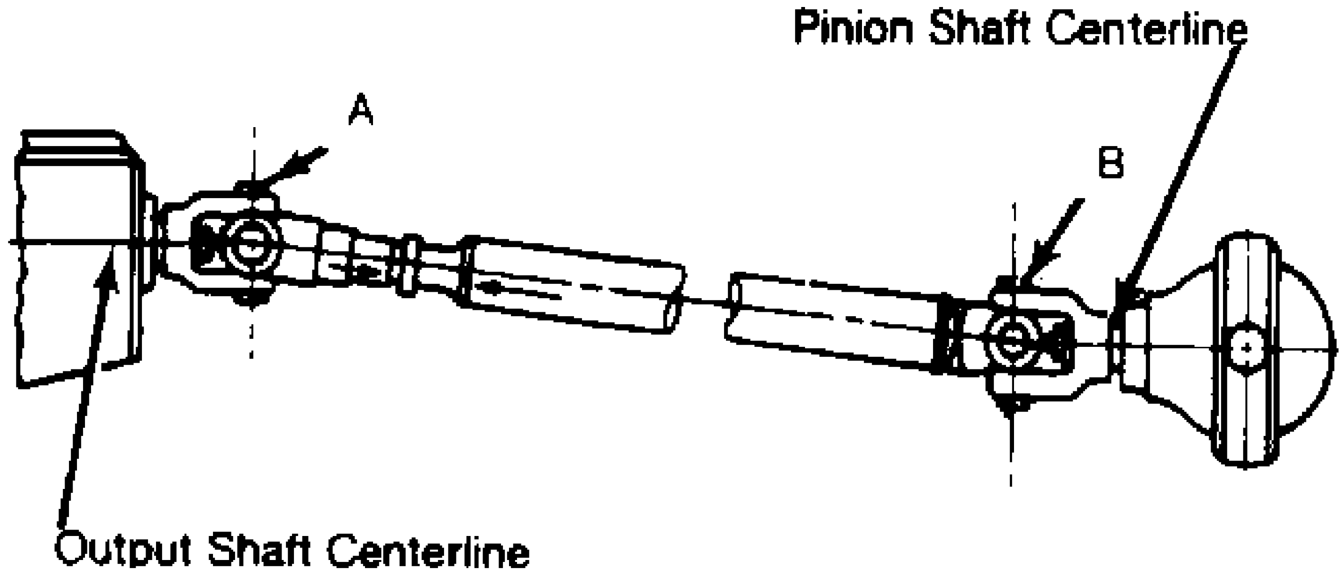


28878
Fig. 5: Typical "Broken Back" Type Drive Shaft Alignment
Angle "A" equals angle "B".

2) With nonparallel or "broken back" type installation, working angles of universal joints of given drive shaft are equal. Angle "A" = angle "B".

3) This is calculated as follows: angle of output shaft centerline is subtracted from angle of drive shaft. Difference should equal angle of drive shaft subtracted from pinion shaft angle.

4) Parallel type joints maintain constant velocity between output shaft and pinion shaft. Vibration is minimized and component life maximized when universal joints are parallel.

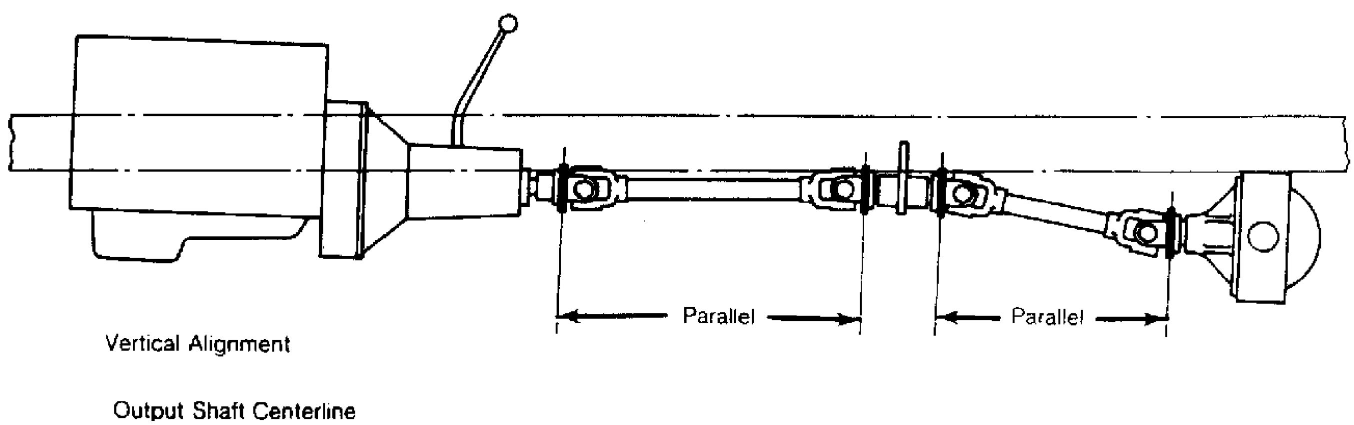


28879
Fig. 6: Aligning One-Piece Drive Shaft
Yokes must be parallel.

5) Using dial indicator, measure runout of transmission flange, center bearing flange and pinion flange. If runout exceeds .003-.005" (.08-.13 mm), replace flange.

6) If dial indicator cannot be used, push rod with snug fit through flange bearing bore. See if it aligns with opposite flange bore. If not, replace flange.

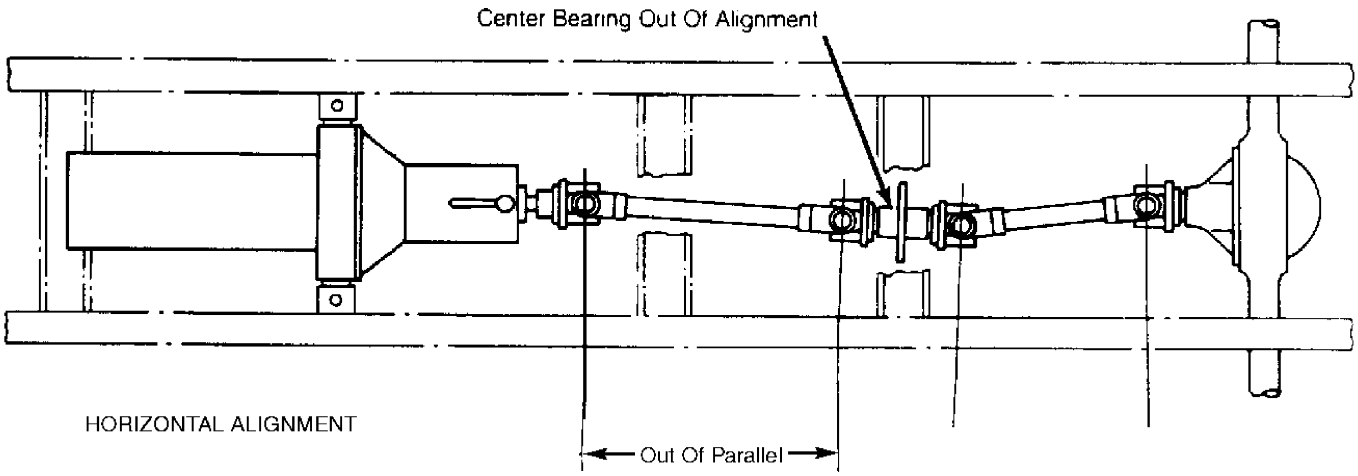
7) Rotate transmission flange until it is vertical, measuring from side. Check center bearing and pinion flanges. They cannot be more than one degree off vertical. See DRIVE SHAFT PHASING in this article.



28685
Fig. 7: Vertical Alignment of Drive Shaft
Flanges in pairs should be parallel.

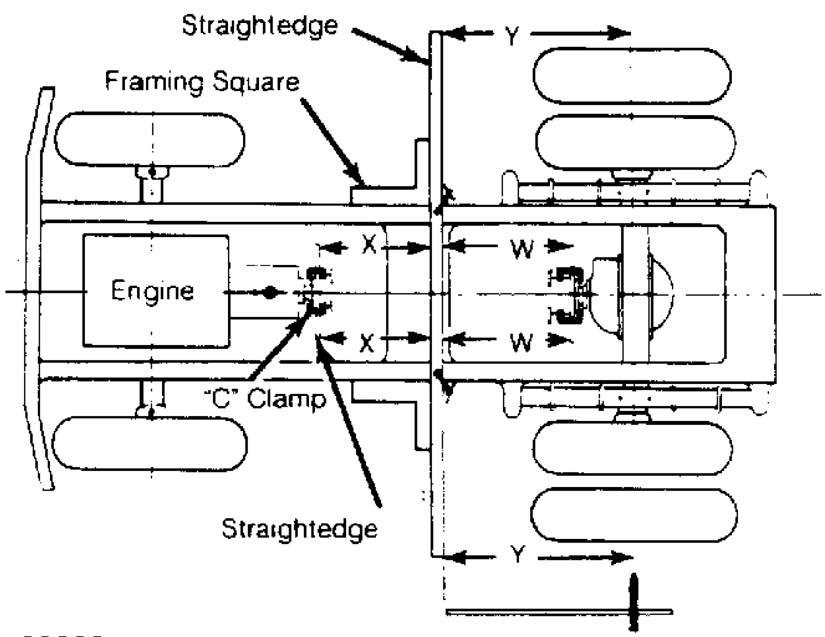
8) Rotate transmission flange until it is vertical, measured from side. Measure angle from end and record it. Check all other flanges for same angle. They must be within 1/2 degree of each other. Adjust as required.

9) If difficulty is encountered when making these adjustments, horizontal alignment should be checked. Even though vertical alignment is correct, horizontal alignment can be badly out of adjustment. This is often found after major component replacement or repair of serious accident damage. See Fig. 8.



28881
Fig. 8: Horizontal Alignment of Drive Shaft
Plane of trunnions should be parallel.

10) To make horizontal alignment checks, set straightedges up. See Fig. 9. Set transmission output flange horizontal and clamp straightedge to flange in a horizontal plane. Repeat procedure with drive pinion flange. Ensure that flanges are horizontal by checking angle of straightedge with spirit level.



28882
Fig. 9: Checking Horizontal Alignment
Measure at 6 points shown using straightedges and framing squares.

11) Using straightedge that is 12" longer than width of rear wheel track at 90 degrees, clamp to frame side rails. Use large

framing squares to align straightedge with side rails.

12) Measure distance "X" at each side. If both measurements are not within 1/16" (1.6 mm) of each other, transmission flange is horizontally misaligned.

13) Measure distance "Y" (edge of straightedge to axle shaft centerline) at each side. If 2 dimensions are not within 1/8" (3.2 mm) of each other, axle housing is misaligned.

14) Measure distance "W" at each side. If both measurements are not within 1/16" (1.6 mm) of each other, pinion flange is horizontally misaligned.

* DRIVETRAIN SYSTEMS UNIFORM INSPECTION GUIDELINES *

1988 Jeep Cherokee

GENERAL INFORMATION
Drivetrain/Transmission Motorist Assurance Program
Standards For Automotive Repair

All Makes and Models

INTRODUCTION TO MOTORIST ASSURANCE PROGRAM (MAP)

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INTRODUCTION TO MOTORIST ASSURANCE PROGRAM (MAP)

OVERVIEW OF MOTORIST ASSURANCE PROGRAM

The Motorist Assurance Program is the consumer outreach effort of the Automotive Maintenance and Repair Association, Inc. (AMRA). Participation in the Motorist Assurance Program is drawn from retailers, suppliers, independent repair facilities, vehicle manufacturers and industry associations.

Our organization's mission is to strengthen the relationship between the consumer and the auto repair industry. We produce materials that give motorists the information and encouragement to take greater responsibility for their vehicles-through proper, manufacturer-recommended, maintenance. We encourage participating service and repair shops (including franchisees and dealers) to adopt (1) a Pledge of Assurance to their Customers and (2) the Motorist Assurance Program Standards of Service. All participating service providers have agreed to subscribe to this Pledge and to adhere to the promulgated Standards of Service demonstrating to their customers that they are serious about customer satisfaction.

These Standards of Service require that an inspection of the vehicle's (problem) system be made and the results communicated to the customer according to industry standards. Given that the industry did not have such standards, the Motorist Assurance Program successfully promulgated industry inspection communication standards in 1994-95 for the following systems: Exhaust, Brakes, ABS, Steering and Suspension, Engine Maintenance and Performance, HVAC, and Electrical Systems. Further, revisions to all of these inspection were recently published. Further, revisions to all of these inspection communication standards are continually republished. In addition to these, standards for Drive Train and Transmissions have recently been promulgated. Participating shops utilize these Uniform Inspection & Communication Standards as part of the inspection process and for communicating their findings to their customers.

The Motorist Assurance Program continues to work cooperatively and proactively with government agencies and consumer groups toward solutions that both benefit the customer and are mutually acceptable to both regulators and industry. We maintain the belief that industry must retain control over how we conduct our business, and we must be viewed as part of the solution and not part of the problem. Meetings with state and other government officials (and their representatives), concerned with auto repair and/or consumer protection, are conducted. Feedback from these sessions is brought back to the association, and the program adjusted as needed.

To assure auto repair customers recourse if they were not satisfied with a repair transaction, the Motorist Assurance Program offers mediation and arbitration through MAP/BBB-CARE and other non-profit organizations. MAP conducted pilot programs in twelve states before announcing the program nationally in October, 1998. During the pilots, participating repair shops demonstrated their adherence to the Pledge and Standards and agreed to follow the UICS in communicating the results of their inspection to their customers. To put some "teeth" in the program, an accreditation requirement for shops was initiated. The requirements are stringent, and a self-policing method

has been incorporated which includes the "mystery shopping" of outlets.

We welcome you to join us as we continue our outreach... with your support, both the automotive repair industry and your customers will reap the benefits. Please visit MAP at our Internet site www. motorist.org or contact us at:

1444 I Street, NW Suite 700
Washington, DC 20005
Phone (202) 712-9042 Fax (202) 216-9646
January 1999

MAP UNIFORM INSPECTION GENERAL GUIDELINES

OVERVIEW OF SERVICE REQUIREMENTS & SUGGESTIONS

It is MAP policy that all exhaust, brake, steering, suspension, wheel alignment, drive-line, engine performance and maintenance, and heating, ventilation and air conditioning, and electrical services be offered and performed under the standards and procedures specified in these sections.

Before any service is performed on a vehicle, an inspection of the appropriate system must be performed. The results of this inspection must be explained to the customer and documented on an inspection form. The condition of the vehicle and its components will indicate what services/part replacements may be "Required" or "Suggested". In addition, suggestions may be made to satisfy the requests expressed by the customer.

When a component is suggested or required to be repaired or replaced, the decision to repair or replace must be made in the customer's best interest, and at his or her choice given the options available.

This section lists the various parts and conditions that indicate a required or suggested service or part replacement. Although this list is extensive, it is not fully inclusive. In addition to this list, a technician may make a suggestion. However, any suggestions must be based on substantial and informed experience, or the vehicle manufacturer's recommended service interval and must be documented.

Some conditions indicate that service or part replacement is required because the part in question is no longer providing the function for which it is intended, does not meet a vehicle manufacturer's design specification or is missing.

Example:
An exhaust pipe has corroded severely and has a hole in it through which exhaust gases are leaking. Replacement of the exhaust pipe in this case is required due to functional failure.

Example:
A brake rotor has been worn to the point where it measures less than the vehicle manufacturer's discard specifications. Replacement of the rotor is required because it does not meet design specifications.

Some conditions indicate that a service or part replacement is suggested because the part is close to the end of its useful life or addresses a customer's need, convenience or request. If a customer's vehicle has one of these conditions, the procedure may be only to suggest service.

Example:
An exhaust pipe is rusted, corroded or weak, but no leaks are present. In this case, the exhaust pipe has not failed. However, there is evidence that the pipe may need replacement in the near future. Replacement of the pipe may be suggested for the customer's convenience in avoiding a future problem.

Example:
The customer desires improved ride and/or handling, but the vehicle's shocks or struts have not failed. In this case, replacement may be suggested to satisfy the customer's wishes. In this case, replacement of the shocks or struts may not be sold as a requirement.

A customer, of course, has the choice of whether or not a shop will service his or her vehicle. He or she may decide not to follow some of your suggestions. When a repair is required, a MAP shop must refuse partial service on that system if, in the judgment of the service provider, proceeding with the work could create or continue an unsafe condition. When a procedure states that required or suggested repair or replacement is recommended, the customer must be informed of the generally acceptable repair/replacement options whether or not performed by the shop.

When presenting suggested repairs to the customer, you must present the facts, allowing the customer to draw their own conclusions and make an informed decision about how to proceed.

The following reasons may be used for required and suggested services. These codes are shown in the "Code" column of the MAP Uniform Inspection & Communications Standards that follow:

Reasons to Require Repair or Replacement

A - Part no longer performs intended purpose
B - Part does not meet a design specification (regardless of performance)
C - Part is missing

NOTE: When a repair is required, the shop must refuse partial service to the system in question, if the repair creates or continues an unsafe condition.

Reasons to Suggest Repair or Replacement

1 - Part is close to the end of its useful life (just above discard specifications, or weak; failure likely to occur soon, etc.)
2 - To address a customer need, convenience, or request (to stiffen ride, enhance performance, eliminate noise, etc.)
3 - To comply with maintenance recommended by the vehicle's Original Equipment Manufacturer (OEM)
4 - Technician's recommendation based on substantial and informed experience

NOTE: Suggested services are always optional. When presenting suggested repairs to the customer, you must present the facts, allowing the customer to draw their own conclusions and make an informed decision about how to proceed.

DRIVE/POWER TRAIN ASSEMBLIES

SERVICE PROCEDURES REQUIRED AND SUGGESTED FOR PROPER VEHICLE OPERATION

NOTE: Whenever transmission or drivetrain service is performed that affects the suspension alignment, for example, removing the engine cradle, it is required that the alignment be checked and corrected if necessary.

AUTOMATIC TRANSMISSION/TRANSAXLE ASSEMBLIES

AUTOMATIC TRANSMISSION/TRANSAXLE ASSEMBLY INSPECTION

Condition	Code	Procedure
Any internal component failure that requires removal of the assembly from the vehicle for service. (1)	A	(2) Require repair or replacement of the automatic transmission/transaxle assembly.

(1) - It is Required that the torque converter and all other failure related components be inspected for cause and condition.
(2) - For components not requiring removal of the assembly, refer to the component listing in this document.

DIFFERENTIAL AND FINAL DRIVE ASSEMBLIES

NOTE: Does not include half shafts.

DIFFERENTIAL AND FINAL DRIVE ASSEMBLY INSPECTION

Condition	Code	Procedure
Any internal component failure that requires removal of the assembly from the vehicle for service. (1)	A	Require repair or replacement of the differential assembly.

(1) - For components not requiring removal of the assembly, refer to the component listing in this document.

MANUAL TRANSMISSION/TRANSAXLE ASSEMBLIES

MANUAL TRANSMISSION/TRANSAXLE ASSEMBLY INSPECTION

Condition	Code	Procedure
Any internal component failure that requires removal of the assembly from the vehicle for service. (1)	A	Require repair or replacement of the manual transmission/transaxle assembly.

(1) - For components not requiring removal of the assembly,

refer to the component listing in this document.

TRANSFER CASE ASSEMBLIES

TRANSFER CASE ASSEMBLY INSPECTION

Condition	Code	Procedure
Any internal component failure that requires removal of the assembly from the vehicle for service. (1)	A	Require repair or replacement of the transfer case differential assembly.

(1) - For components not requiring removal of the assembly, refer to the component listing in this document.

DRIVE TRAIN/COMPONENTS

The conditions listed for the components included in this section assume that the problem has been isolated to the specific component through proper testing.

ACTUATORS (ELECTRICAL)

ACTUATOR (ELECTRICAL) INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Connector broken	A	Require repair or replacement.
Connector (Weatherpack type) leaking	A	Require repair or replacement.
Connector melted, affecting performance	A	(1) Require repair or replacement.
Connector melted, not affecting performance	2	(1) Suggest repair or replacement.
Connector missing	C	Require replacement.
Inoperative	A	(2) Require replacement.
Missing	C	Require replacement.
Noisy	2	Suggest repair or replacement.
Out of adjustment	B	Require repair or replacement.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(1) Require repair or replacement.
Terminal burned, not affecting performance	1	(1) Suggest repair or

		replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	1	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - Inoperative includes intermittent operation or out of OEM specification.

ACTUATORS (VACUUM)

ACTUATOR (VACUUM) INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Connector broken	A	Require repair or replacement.
Connector (Weatherpack type) leaking	A	Require repair or replacement.
Connector melted, affecting performance	A	(1) Require repair or replacement.
Connector melted, not affecting performance	2	(1) Suggest repair or replacement.
Connector missing	C	Require replacement.
Inoperative	A	(2) Require replacement.
Leaking (vacuum)	A	Require repair or replacement.
Linkage bent, affecting performance	A	Require repair or replacement of linkage.
Linkage bent, not affecting performance	2	Suggest repair or replacement of linkage.
Linkage binding, affecting performance	A	Require repair or replacement of linkage.
Linkage binding, not affecting performance	1	Suggest repair or replacement of linkage.
Linkage broken	A	Require repair or replacement of linkage.
Linkage loose, affecting performance	A	Require repair or replacement of linkage.
Linkage loose, not affecting performance	1	Suggest repair or replacement of linkage.

Linkage missing	C	Require replacement.
Linkage noisy	2	Suggest repair or replacement.
Missing	C	Require replacement.
Noisy	2	Suggest repair or replacement.
Out of adjustment	A	Require repair or replacement.
Terminal burned, affecting performance	A	(1) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - Inoperative includes intermittent operation or out of OEM specification.

AXLES

AXLE INSPECTION

Condition	Code	Procedure
Bent	A	Require replacement.
Broken	A	Require replacement.
End play exceeds specifications	B	Require repair or replacement.
Flange bent	A	Require replacement.
Flange threads stripped	A	Require repair or replacement.
Twisted	A	Require replacement.
Worn, affecting performance	A	Require replacement.

BEARINGS AND RACES

NOTE: When replacing or repacking bearings, grease seal replacement is required. You are not required to replace these components in axle sets. Determine the need to replace based upon the individual component conditions that follow.

BEARING AND RACE INSPECTION

Condition	Code	Procedure
Bearing end-play exceeds specifications	B	Require adjustment of bearing, if possible. If proper adjustment cannot be obtained, require replacement of bearing assembly.
Bearing rollers, balls or races are worn, pitted, or		

feel rough when rotated as an assembly	B	Require replacement of bearing assembly.

BELL CRANKS

BELL CRANK INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Bent	A	Require repair or replacement.
Broken	A	Require repair or replacement.
Cracked	A	Require repair or replacement.
Missing	C	Require replacement.
Worn, affecting performance	A	Require repair or replacement.

BELL HOUSINGS

See HOUSINGS (BELL, CASE, TAIL (EXTENSION) AND AUXILIARY).

BUSHINGS (EXTERNAL)

BUSHING (EXTERNAL) INSPECTION

Condition	Code	Procedure
Attaching hardware bent	B	Require repair or replacement of bent part if available; otherwise, replace bushing.
Attaching hardware broken	A	Require replacement of broken part if available; otherwise, replace bushing.
Attaching hardware corroded, affecting structural integrity	A	Require replacement of corroded part if available; otherwise, replace bushing.
Attaching hardware incorrect	A	Require replacement of incorrect part if available; otherwise, replace bushing.
Attaching hardware loose	A	Require repair or replacement of loose part if available; otherwise, replace bushing.
Attaching hardware missing	C	Require replacement of missing part if available; otherwise, replace bushing.

Attaching hardware threads damaged	A	Require repair or replacement of part with damaged threads if available; otherwise, replace bushing.
Attaching hardware threads stripped (threads missing)	A	Require replacement of part with stripped threads if available; otherwise, replace bushing.
Binding	A	Require repair or replacement.
Contaminated	1	Suggest replacement.
Deteriorated, affecting performance	A	Require repair or replacement.
Distorted, affecting performance	A	Require repair or replacement.
Missing	A	Require replacement.
Noisy	2	(1) Further inspection required.
Rubber separating from internal metal sleeve on bonded bushing	A	Require replacement.
Seized	A	Require replacement.
Shifted (out of position)	B	Require repair or replacement.
Split	A	Require replacement.
Surface cracking (weather-checked)	..	No service suggested or required.
Worn, affecting performance	A	Require repair or replacement.
Worn close to the end of its useful life	1	Suggest replacement.

(1) - If noise isolated to bushing, suggest repair or replacement.

CAUTION: Use only approved lubricant on rubber bushings. Petroleum-based lubricants may damage rubber bushings.

CABLES (SPEEDOMETER)

CABLE (SPEEDOMETER) INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Bent	A	Require repair or replacement.
Binding	A	Require repair or replacement.
Bracket bent, affecting performance	A	Require repair or replacement.
Bracket bent, not affecting performance	..	No service suggested or

required.

Bracket broken, affecting performance	A	Require replacement.
Bracket broken, not affecting performance	..	No service suggested or required.
Bracket corroded, affecting performance	A	Require repair or replacement.
Bracket corroded, not affecting performance	2	Suggest repair or replacement.
Bracket cracked, affecting performance	A	Require repair or replacement.
Bracket cracked, not affecting performance	1	Suggest repair or replacement.
Bracket loose, affecting performance	A	Require repair or replacement.
Bracket loose, not affecting performance	1	Suggest repair or replacement.
Bracket missing	C	Require replacement.
Broken	A	Require replacement.
Cracked	A	Require repair or replacement.
Disconnected	A	Require repair or replacement.
Kinked	A	Require repair or replacement.
Melted	A	(1) Require repair or replacement.
Missing	C	Require replacement.
Noisy	2	Suggest repair or replacement.
Routed incorrectly	2	Suggest repair.
Seized	A	Require repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.

CABLES (TV, DETENT AND SHIFT)

CABLE (TV, DETENT AND SHIFT) INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Bent	A	Require repair or replacement.
Binding	A	Require repair or replacement.
Bracket bent, affecting performance	A	Require repair or replacement.
Bracket bent, not affecting performance	..	No service suggested or required.
Bracket broken, affecting performance	A	Require replacement.
Bracket broken, not affecting performance	..	No service suggested or required.
Bracket corroded, affecting performance	A	Require repair or replacement.

Bracket corroded, not affecting performance	2	Suggest repair or replacement.
Bracket cracked, affecting performance	A	Require repair or replacement.
Bracket cracked, not affecting performance	1	Suggest repair or replacement.
Bracket loose, affecting performance	A	Require repair or replacement.
Bracket loose, not affecting performance	1	Suggest repair or replacement.
Bracket missing	C	Require replacement.
Broken	A	Require replacement.
Cracked	A	Require repair or replacement.
Disconnected	A	Require repair or replacement.
Frayed	A	Require replacement.
Kinked	A	Require repair or replacement.
Melted	A	(1) Require repair or replacement.
Missing	C	Require replacement.
Noisy	2	Suggest repair or replacement.
Out of adjustment	B	(2) Require repair or replacement.
Routed incorrectly	2	Suggest repair.
Seized	A	Require repair or replacement.
Self-adjuster inoperative	A	Require repair or replacement of self-adjuster.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - Cable replacement is required if it cannot be adjusted within specifications.

CARRIER BEARINGS

See INTERMEDIATE SHAFT SUPPORT BEARINGS.

CLUTCH CABLES AND CABLE HOUSINGS

CLUTCH CABLE AND CABLE HOUSING INSPECTION

Condition	Code	Procedure
Broken	A	Require replacement.
Cable bent	A	Require replacement.
Cable binding	A	Require repair or replacement.
Cable mounting loose	B	Require repair or replacement.
Cable out of adjustment	B	Require repair or replacement.
Frayed	B	Require replacement.
Housing heat-damaged	1	Suggest replacement.
Missing	C	Require replacement.
Noisy	2	Suggest repair or replacement.
Seized	A	Require replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.
Worn, affecting performance	A	Require replacement.

CLUTCH DISCS (MANUAL TRANSMISSION)

CLUTCH DISC (MANUAL TRANSMISSION) INSPECTION

Condition	Code	Procedure
Backing plate cracked	A	Require replacement.
Broken	A	Require replacement.
Contaminated with oil	A	Require replacement.
Damper cushion broken	A	Require replacement.
Damper cushion collapsed	A	Require replacement.
Damper spring collapsed	A	Require replacement.
Damper spring missing	C	(1) Require replacement.
Friction material cracked through	B	Require replacement.
Friction material flaking or chunking	B	Require replacement.
Friction material surface cracking	B	No service suggested or required.
Grooved	B	No service suggested or required unless the pressure plate or flywheel is being resurfaced or replaced. In this case, replacement of clutch disc is required.
Ridged	B	No service suggested or required unless the pressure plate or flywheel is being resurfaced or replaced. In this case, replacement of clutch disc is required.
Splines worn, affecting performance	A	Require replacement.
Warped	A	Require replacement.
Wear exceeds specifications (where applicable)	B	Require replacement.
Worn close to the end of its useful life	1	Suggest replacement.
Worn, affecting performance	A	Require replacement.

(1) - Not all clutch discs have springs in all spring chambers on the disc.

CLUTCH FORKS

CLUTCH FORK INSPECTION

Condition	Code	Procedure
Bent	B	Require replacement.
Broken	A	Require repair or replacement.
Cracked	B	Require repair or replacement.
Worn close to the end of its useful life	1	Suggest replacement.
Worn, affecting performance	A	Require replacement.

CLUTCH LINKAGES (MECHANICAL)

See LINKAGES (EXTERNAL).

CLUTCH MASTER CYLINDERS

CLUTCH MASTER CYLINDER INSPECTION

Condition	Code	Procedure
Cover gasket distorted	A	Require replacement of cover gasket.
Cover gasket gummy	A	Require replacement of cover gasket.
Cylinder leaking fluid from rear of bore	A	Require repair or replacement.
Cylinder leaking fluid internally	A	Require replacement.
Dust boot missing	C	Require replacement of dust boot.
Dust boot punctured	A	Require replacement of dust boot.
Dust boot torn	A	Require replacement of dust boot.
Fluid level incorrect	B	Require fluid level adjustment.
Housing damaged, affecting performance	A	Require repair or replacement.
Master cylinder has residue in reservoir (make parallel w/brakes when they are done)	2	(1) Further inspection required.
Threads damaged	A	Require repair replacement
Threads stripped (threads missing)	A	Require replacement.

(1) - DO NOT replace master cylinder unless it exhibits conditions listed for replacement. You may suggest fluid change according to OEM service intervals.

CLUTCH PEDALS

CLUTCH PEDAL INSPECTION

Condition	Code	Procedure
Bent, affecting performance	A	Require repair or replacement.
Broken	A	Require repair or replacement.
Pedal pad missing	C	Require replacement of pedal pad.
Pivot bushings worn, affecting performance	A	Require replacement of pivot bushings.

CLUTCH PIVOTS

CLUTCH PIVOT INSPECTION

Condition	Code	Procedure
Bent	A	Require replacement.
Broken	A	Require repair or replacement.
Cracked	A	Require repair or replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.
Worn close to the end of its useful life	1	Suggest replacement.
Worn, affecting performance	A	Require replacement.

CLUTCH PRESSURE PLATES

See PRESSURE PLATES.

CLUTCH RELEASE BEARINGS

CLUTCH RELEASE BEARING INSPECTION

Condition	Code	Procedure
Collar broken	A	Require replacement.
Cracked	A	Require replacement.
Rough when rotated as an assembly	B	Require replacement.
Seized	A	Require replacement.
Wear exceeds specifications	B	Require replacement.
Worn close to the end of its useful life	1	Suggest replacement.
Worn, affecting performance	A	Require replacement.

CLUTCH SLAVE CYLINDERS (CONCENTRIC)

CLUTCH SLAVE CYLINDER (CONCENTRIC) INSPECTION

Condition	Code	Procedure
Bearing rough when rotated as an assembly	B	Require replacement.
Bearing seized	A	Require replacement.
Bleeder pipe leaks	A	Require repair or replacement.
Carrier assembly worn, affecting performance	A	Require replacement.
Collar broken	A	Require replacement.
Cracked	A	Require replacement.
Housing leaks	A	Require replacement.
Inoperative	A	Require replacement.
Release binding	A	Require replacement.
Spring broken	A	Require replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.
Worn, affecting performance	A	Require replacement.

CLUTCH SLAVE CYLINDERS (CONVENTIONAL OR EXTERNAL)

CLUTCH SLAVE CYLINDER (CONVENTIONAL OR EXTERNAL) INSPECTION

Condition	Code	Procedure
Binding	A	Require repair or replacement.
Bleeder port damaged (not repairable)	A	(1) Require replacement.
Bleeder port damaged (repairable)	A	(1) Require repair.
Bleeder screw broken off in slave cylinder	A	(1) Require replacement.
Bleeder screw seized	A	(2) Require replacement.
Bore corroded (pitted)	B	Require replacement.
Bore grooved	A	Require replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.

(1) - Only required if the hydraulic system must be opened.
(2) - Seized is defined as a bleeder screw that cannot be removed after a practical attempt at removing it has been made.

COMPANION FLANGES

See YOKES AND SLIP YOKES.

CONNECTORS

See WIRING HARNESSES AND CONNECTORS.

COOLER BYPASS VALVES

COOLER BYPASS VALVE INSPECTION

Condition	Code	Procedure
Inoperative	A	Require replacement.
Installed incorrectly	A	Require repair.
Leaking	A	Require repair or replacement.
Restricted	A	Require repair or replacement.

COOLER LINES

COOLER LINE INSPECTION

Condition	Code	Procedure
Abrasion damage, affecting structural integrity	A	Require repair or replacement.
Abrasion damage, not affecting structural integrity	..	No service suggested or required.
Application incorrect	B	Require replacement.
Attaching hardware broken	A	Require repair or replacement of hardware.

Condition	Code	Procedure
Attaching hardware missing	C	.... Require replacement of hardware.
Attaching hardware not functioning	A	... Require repair or replacement of hardware.
Clamp corroded, not reusable	1	.... Suggest replacement.
Connected incorrectly ...	A	.... Require repair.
Corroded, affecting structural integrity ...	A	.... Require replacement.
Corroded, not affecting structural integrity ...	..	.... No service suggested or required.
Cracked	A	.. Require repair or replacement.
Fitting type incorrect (such as compression fitting)	B	.... Require replacement.
Flange leaking	A	.. Require repair or replacement.
Insufficient clamping force, allowing hose to leak	A	.. Require repair or replacement.
Leaking	A	.. Require repair or replacement.
Melted	1	.. Suggest repair or replacement.
Missing	C	.... Require replacement.
Outer covering damaged to the extent that the inner fabric is visible	A	.... Require replacement.
Protective sleeves damaged	2	. Suggest replacement of sleeves.
Protective sleeves missing	C	. Require replacement of sleeves.
Restricted, affecting performance	A	.. Require repair or replacement.
Routed incorrectly	2	.... Require repair.
Swollen	1	.... Suggest replacement.
Threads damaged	A	.. Require repair or replacement.
Threads stripped (threads missing)	A	.... Require replacement.
Type incorrect	1	.. Suggest repair or replacement.

COOLERS

See TRANSMISSION COOLERS.

CV JOINTS

CV JOINT INSPECTION

Condition	Code	Procedure
Bearing, bushing or seal surface worn, affecting performance	A	.. Require repair or replacement.
Boot clamp broken	A	... Require repair or replacement of clamp.
Boot clamp loose	A	... Require repair or replacement of clamp.
Boot clamp missing	C	... Require repair or replacement of clamp.
Boot leaking	A	. Require replacement of CV boot.
Boot surface cracked,		

not leaking	2	. Suggest replacement of CV boot.
Cage broken	A	... Require repair or replacement of CV joint.
Housing damaged to the extent that it no longer performs its intended function	A	.... (1) Require repair or replacement of CV joint.
Housing worn to the extent that it no longer performs its intended function ..	A	.... (1) Require repair or replacement of CV joint.
Holes elongated	A	.... Require replacement.
Internal parts binding ..	A	.. Require repair or replacement.
Internal parts worn	A	.. Require repair or replacement.
Lubricant missing	C	... Require cleaning, inspection, and repacking of CV joint.
Threads damaged	A	.. Require repair or replacement.
Threads stripped (threads missing)	A	.... Require replacement.

(1) - Housing assembly may appear blue in color from normal manufacturing process of heat-treating the housing.

DIP STICK TUBES

DIP STICK TUBE INSPECTION

Condition	Code	Procedure
Broken	A	.. Require repair or replacement.
Checkball missing	C	.. Suggest repair or replacement.
Cracked	A	.. Require repair or replacement.
Hold down bracket broken	A	.. Require repair or replacement.
Hold down bracket missing	C	.... Require replacement.
Leaking	A	.. Require repair or replacement.
Missing	C	.... Require replacement.
Threads damaged	A	.. Require repair or replacement.
Threads stripped (threads missing)	A	.... Require replacement.

DIP STICKS (FLUID LEVEL INDICATORS)

DIP STICK (FLUID LEVEL INDICATOR) INSPECTION

Condition	Code	Procedure
Application incorrect ...	B	.... Require replacement.
Broken	A	.... Require replacement.
Compressed	A	.. Require repair or replacement.
Missing	C	.... Require replacement.
Modified	A	.... Require replacement.
Stretched	A	.. Require repair or replacement.

DOWEL PINS, GUIDES AND PILOT HOLES

DOWEL PIN, GUIDE AND PILOT HOLE INSPECTION

Condition	Code	Procedure
Application incorrect	B	Require repair or replacement.
Cracked	A	Require repair or replacement.
Distorted	A	Require repair or replacement.
Missing	C	Require replacement.
Positioned incorrectly	B	Require repair or replacement.
Stepped	A	Require repair or replacement.
Worn to the extent that it no longer performs its intended function	A	Require repair or replacement.

DRIVE SHAFT FLANGES

See COMPANION FLANGES.

DRIVE SHAFTS AND HALF SHAFTS

DRIVE SHAFT AND HALF SHAFT INSPECTION

Condition	Code	Procedure
Balance weight missing	C	Require repair or replacement.
Bearing cap bore distorted	A	Require repair or replacement.
Bent	A	Require replacement.
Bolt holes elongated	A	Require repair or replacement.
Bushing or seal surface worn, affecting performance	A	Require repair or replacement.
Leaking through soft yoke plug	A	Require repair or replacement of soft yoke plug.
Out of balance	A	Require repair or replacement.
Retainer strap bent	A	Require replacement of retainer strap.
Slip yoke broken	A	Require replacement.
Splines worn, affecting performance	A	Require replacement.
Splines worn close to the end of their useful life	1	Suggest replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.
U-bolt damaged, affecting performance	A	Require replacement of U-bolts.
Yoke damaged, affecting performance	A	Require repair or replacement.

DUST BOOTS

NOTE: Does not include CV boots.

DUST BOOT INSPECTION

Condition	Code	Procedure
Cracked, not leaking	1	Suggest replacement.
Missing	C	Require replacement.
Leaking	A	Require repair or replacement.

Torn	A	Require replacement.

ENGINE MOUNTS

See MOUNTS (ENGINE, TRANSAXLE AND TRANSMISSION).

EXCITER RINGS

See TOOTHED RINGS (TONE WHEELS).

FILLER TUBES

See DIP STICK TUBES.

FILTERS AND SCREENS

FILTER AND SCREEN INSPECTION

Condition	Code	Procedure
At service interval	3	Suggest replacement.
Bent	A	Require repair or replacement.
Exceeding service interval	3	Suggest replacement.
Missing	C	Require replacement.
Near service interval	3	Suggest replacement.
Restricted	A	(1) Require repair or replacement.
Torn	A	Require replacement.
Worn, affecting performance (metal or nylon screen type)	A	Require repair or replacement.

(1) - Further inspection may be required to determine the source of restriction or contamination.

FLANGES

See COMPANION FLANGES.

FLEX PLATES

FLEX PLATE INSPECTION

Condition	Code	Procedure
Bent, affecting performance	A	Require replacement.
Bent, not affecting performance	..	No service suggested or required.
Bolt or stud holes elongated	B	Require replacement.
Broken	A	Require replacement.
Cracked	A	Require replacement.
Ring gear worn close to the end of its useful life	1	Suggest replacement.
Ring gear worn to the extent that it no longer		

performs its intended function	A	Require replacement.
Weights missing	A	Require replacement.

FLUID LEVEL INDICATORS

See DIP STICKS (FLUID LEVEL INDICATORS).

FLUIDS AND LUBRICANTS

FLUID AND LUBRICANT INSPECTION

Condition	Code	Procedure
Application incorrect	B	(1) Require replacement.
At service interval	3	Suggest replacement.
Beyond service interval	3	Suggest replacement.
Burned	..	(2) Further inspection required.
Contaminated, for example, fluid other than hydraulic fluid present	A or B	(3)(4) Require service.
Exceeding service interval	3	Suggest replacement.
Hydraulic fluid incorrect	B	(5) Require service.
Level incorrect	B	Require correction of fluid level.
Near service interval	3	Suggest replacement.
Rubber master cylinder cover gasket distorted and gummy	A	(3) Require service.
Varnished	..	(6) Further inspection required.

(1) - Determine and correct cause.
(2) - Fluid that is burned indicates a serious problem. Determine and correct the cause.
(3) - If a fluid other than hydraulic fluid is present in the hydraulic system which DOES affect the rubber parts, the required service is to: 1) remove all components having rubber parts from the system, 2) flush lines with denatured alcohol or hydraulic cleaner, 3) repair or replace all components having rubber parts, and 4) bleed and flush with correct hydraulic fluid. (Code A)
(4) - If a fluid other than hydraulic fluid is present in the hydraulic system which DOES NOT affect the rubber parts, the required service is to flush and fill with the correct hydraulic fluid. (Code B)
(5) - If a fluid other than specification hydraulic fluid is present in the hydraulic system, the required service is to flush and fill with the correct hydraulic fluid.
(6) - Fluid that is varnished may indicate a serious problem. Determine and correct the cause.

FLYWHEELS

NOTE: Clutch disc replacement does not necessitate flywheel reconditioning, unless other conditions justify the reason to do so.

FLYWHEEL INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Cracked (other than mounting area)	A	(1) Require resurfacing or replacement.
Cracks in mounting area	B	Require replacement.
Hard spots	B	Require repair or replacement.
Ring gear broken	A	Require replacement of ring gear.
Ring gear teeth worn, affecting performance	A	Require replacement of ring gear.
Runout exceeds specifications	B	Require repair or replacement.
Scored	B	Require repair or replacement.
Surface cracks after resurfacing to manufacturer’s minimum specifications	B	Require replacement.
Wear exceeds specifications	B	Require replacement.
Worn close to the end of its useful life	1	Suggest replacement.
Worn, affecting performance	A	Require repair or replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.

(1) – Some manufacturers allow slight surface cracking in the friction surface.

FORCE MOTORS

See ACTUATORS (ELECTRICAL).

GUIDES

See DOWEL PINS, GUIDES AND PILOT HOLES.

HALF SHAFTS

See DRIVE SHAFTS AND HALF SHAFTS.

HOSES, LINES AND TUBES

HOSE, LINE AND TUBE INSPECTION

Condition	Code	Procedure

Application incorrect ...	B	.... Require replacement.
Connected incorrectly ...	A	.... Require repair.
Corroded, not reusable ..	1	.... Suggest replacement.
Cracked	A	.... Require replacement.
Dry-rotted	1	.. Suggest repair or replacement.
Hard	1	.. Suggest repair or replacement.
Inner fabric (webbing) damaged	A	.... Require replacement.
Insufficient clamping force, allowing hose to leak	A	.. Require repair or replacement.
Leaking	A	.. Require repair or replacement.
Maintenance intervals ...	3	.... Suggest replacement.
Melted	1	.. Suggest repair or replacement.
Missing	C	.... Require replacement.
Outer covering damaged ..	1	.... Suggest replacement.
Outer covering damaged to the extent that the inner fabric is visible	A	.... Require replacement.
Protective sleeves damaged	2	. Suggest replacement of sleeves.
Protective sleeves missing	2	. Suggest replacement of sleeves.
Restricted, affecting performance	A	.. Require repair or replacement.
Restricted, not affecting performance	2	.. Suggest repair or replacement.
Routed incorrectly	2	.... Suggest replacement.
Safety clip missing	C	.... Require replacement.
Spongy	1	.. Suggest repair or replacement.
Stripped	A	.... Require replacement.
Swollen	B	.... Require replacement.
Threads damaged	A	.. Require repair or replacement.
Threads stripped (threads missing)	A	.... Require replacement.
Type incorrect	1	.. Suggest repair or replacement.

HOUSINGS (BELL, CASE, TAIL (EXTENSION) AND AUXILIARY)

HOUSING (BELL, CASE, TAIL (EXTENSION) AND AUXILIARY) INSPECTION

Condition	Code	Procedure
Bearing race loose in bore	A	.. Require repair or replacement.
Broken, affecting performance	A	.. Require repair or replacement.
Cracked	A	.. Require repair or replacement.
Dowel pin holes worn, affecting performance ..	A	.... (1) Require repair or replacement.
Machined surfaces damaged, affecting performance ..	A	.. Require repair or replacement.
Threads damaged	A	.. Require repair or replacement.
Threads stripped (threads missing)	A	.... Require replacement.
Worn, affecting performance	A	.. Require repair or replacement.

(1) - See DOWEL PINS, GUIDES AND PILOT HOLES.

INTERMEDIATE SHAFT SUPPORT BEARINGS

INTERMEDIATE SHAFT SUPPORT BEARING INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Bearing rollers, balls or races are worn, pitted, noisy, or feel rough when rotated as an assembly	A	Require replacement of bearing assembly.
Bracket bent, affecting performance	A	Require repair or replacement.
Bracket bent, not affecting performance	..	No service suggested or required.
Bracket broken, affecting performance	A	Require replacement.
Bracket broken, not affecting performance	..	No service suggested or required.
Bracket corroded, affecting performance	A	Require repair or replacement.
Bracket corroded, not affecting performance	2	Suggest repair or replacement.
Bracket cracked, affecting performance	A	Require repair or replacement.
Bracket cracked, not affecting performance	1	Suggest repair or replacement.
Bracket holes elongated, affecting performance	A	Require repair or replacement.
Bracket holes elongated, not affecting performances)	..	No service suggested or required.
Bracket loose, affecting performance	A	Require repair or replacement.
Bracket loose, not affecting performance	1	Suggest repair or replacement.
Bracket missing	C	Require replacement.
Cracked	..	Require replacement.
Rough (brinelling, spalling)	A	Require replacement.
Rubber deteriorated, affecting performance	A	Require replacement.
Seized	A	Require replacement.

KEY INTERLOCK SYSTEMS

See
SHIFT INTERLOCK SYSTEMS (SELECTOR AND KEY INTERLOCK SYSTEMS).

LIMITED SLIPS

See DIFFERENTIAL AND FINAL DRIVE ASSEMBLIES.

LINES

See HOSES, LINES AND TUBES.

LINKAGES (EXTERNAL)

LINKAGE (EXTERNAL) INSPECTION

Condition	Code	Procedure
Components missing	C	Require replacement of missing components.
Linkage bent, affecting performance	A	Require repair or replacement of linkage.
Linkage bent, not affecting performance	2	Suggest repair or replacement of linkage.
Linkage binding, affecting performance	A	Require repair or replacement of linkage.
Linkage binding, not affecting performance	1	Suggest repair or replacement of linkage.
Linkage broken	A	Require repair or replacement of linkage.
Linkage loose, affecting performance	A	Require repair or replacement of linkage.
Linkage loose, not affecting performance	1	Suggest repair or replacement of linkage.
Linkage missing	C	Require replacement.
Linkage noisy	2	Suggest repair or replacement.
Out of adjustment	B	Require repair or replacement.
Worn to the extent that it no longer performs its intended function	A	Require repair or replacement.

LOCKING HUB ASSEMBLIES

LOCKING HUB ASSEMBLY INSPECTION

Condition	Code	Procedure
Inoperative	A	(1) Require repair or replacement.
Loose	A	Require repair or replacement.
Seized in any position	A	Require repair or replacement.

(1) - Inoperative includes intermittent operation.

LOCKING HUB CONTROL KNOBS

LOCKING HUB CONTROL KNOB INSPECTION

Condition	Code	Procedure

Damaged, affecting performance	A	Require replacement.
Missing	C	Require replacement.
Worn, affecting performance	A	Require replacement.

LUBRICANTS

See FLUIDS AND LUBRICANTS.

METAL-CLAD SEALS

See SEALS.

METALASTIC JOINTS

See RUBBER JOINTS (METALASTIC).

MODULATOR PINS

MODULATOR PIN INSPECTION

Condition	Code	Procedure
Application incorrect	B	Require replacement.
Missing	C	Require replacement.

MODULATORS

MODULATOR INSPECTION

Condition	Code	Procedure
Bent, affecting performance	A	Require replacement.
Contaminated (water, fuel, etc.)	A	(1) Require replacement.
Housing cracked	A	Require replacement.
Inoperative	A	(2) Require replacement.
Leaking fluid externally	A	Require repair or replacement.
Leaking fluid internally	A	Require replacement.
Leaking vacuum	A	Require replacement.
Nipple broken	A	Require replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.

(1) - Further inspection is required to determine the cause of the contamination.
(2) - Inoperative includes intermittent operation or out of OEM specification.

MOUNTS (ENGINE, TRANSAXLE AND TRANSMISSION)

MOUNT (ENGINE, TRANSAXLE AND TRANSMISSION) INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	... Require repair or replacement of hardware.
Attaching hardware missing	C	.... Require replacement of hardware.
Attaching hardware not functioning	A	... Require repair or replacement of hardware.
Broken	A	.... Require replacement.
Leaking (hydraulic mount)	A	.... Require replacement.
Mounting hole worn, affecting performance ..	A	.... Require replacement.
Mounting hole worn, not affecting performance ..	..	.... No service suggested or required.
Rubber deteriorated, affecting performance ..	A	.... Require replacement.
Rubber deteriorated, not affecting performance ..	..	.... No service suggested or required.
Threads damaged	A	.. Require repair or replacement.
Threads stripped (threads missing)	A	.... Require replacement.

ODOMETER DRIVES (MECHANICAL)

See SPEEDOMETER/ODOMETER DRIVES (MECHANICAL).

ODOMETER HEADS (MECHANICAL)

See SPEEDOMETER/ODOMETER HEADS (MECHANICAL).

OIL PANS

See TRANSMISSION PANS.

PANS

See TRANSMISSION PANS.

PILOT HOLES

See DOWEL PINS, GUIDES AND PILOT HOLES.

PRESSURE PLATES

PRESSURE PLATE INSPECTION

Condition	Code	Procedure
Balance weight missing ..	C	.... Require replacement.
Broken	A	.... Require replacement.
Contact surface distorted	B	.... Require replacement.
Cracks	B	.... Require replacement.
Fingers bent	A	.... Require replacement.
Hard spots	B	.... Require replacement.

Scored	B	Require replacement.
Spring rate less than specifications	B	Require replacement.
Worn, affecting performance	A	Require replacement.
Worn beyond specifications	B	Require replacement.
Worn close to the end of its useful life	1	Suggest replacement.

PRESSURE SWITCHES

See SWITCHES.

RACES

See BEARINGS AND RACES.

RUBBER JOINTS (METALASTIC)

These joints may be found on half and/or drive shafts. They are usually found on European vehicles featuring a three-lug drive flange. They may be equipped with a centering ball or pin.

RUBBER JOINT (METALASTIC) INSPECTION

Condition	Code	Procedure
Drive flange bent	A	Require repair or replacement.
Drive flange damaged, affecting performance	A	Require replacement.
Rubber drive joint cracked	2	Suggest replacement.
Rubber drive joint damaged, affecting performance	A	Require replacement.
Rubber drive joint split between mounting holes	A	Require replacement.
Rubber drive joint torn at mounting holes	A	Require replacement.
Rubber drive joint weather-cracked	..	No service suggested or required.

SCREENS

See FILTERS AND SCREENS.

SEALS

SEAL INSPECTION

Condition	Code	Procedure
Leaking	A	(1) Require repair or replacement.

(1) - Require inspection of mating and sealing surface and repair or replace as necessary. Check vent. A plugged

vent may force fluid past the seal.

SEALS (METAL-CLAD)

See SEALS.

SELECTOR INTERLOCK SYSTEMS

See
SHIFT INTERLOCK SYSTEMS (SELECTOR AND KEY INTERLOCK SYSTEMS).

SERVOS

See ACTUATORS (VACUUM).

SHIFT INTERLOCK SYSTEMS (SELECTOR AND KEY INTERLOCK SYSTEMS)

See:
ACTUATORS (ELECTRICAL)
CABLES
LINKAGES (EXTERNAL)
SWITCHES

SENSORS

SENSOR INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Connector broken	A	Require repair or replacement.
Connector (Weatherpack type) leaking	A	Require repair or replacement.
Connector melted	A	(1) Require repair or replacement.
Connector missing	C	Require replacement.
Inoperative	A	(2) Require repair or replacement.
Leaking (vacuum/fluid/air)	A	Require replacement.
Out of adjustment	B	(3) Further inspection required.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(1) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting		

performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - Inoperative includes intermittent operation or out of specification.
(3) - Follow OEM recommended adjustment procedures. Repair or replace if out of specification.

SIDE COVERS

See TRANSMISSION PANS.

SLIP YOKES

See YOKES AND SLIP YOKES.

SOLENOIDS

See:
ACTUATORS (ELECTRICAL)
ACTUATORS (VACUUM)

SPEED SENSORS (ELECTRONIC WHEEL AND VEHICLE)

SPEED SENSOR (ELECTRONIC WHEEL AND VEHICLE) INSPECTION

Condition	Code	Procedure
Air gap incorrect	B	(1) Require adjustment or replacement.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware threads damaged	A	Require repair or replacement of hardware.
Attaching hardware threads stripped (threads missing)	A	Require repair or replacement of hardware.
Connector broken	A	Require repair or replacement.
Connector (Weatherpack type) leaking	A	Require repair or replacement.
Connector melted	A	(2) Require repair or replacement.
Connector missing	C	Require replacement.
Contaminated	A	(3) Require repair or replacement.
Inoperative	B	(4) Require repair or replacement. Further inspection required.
Leaking	A	Require repair or replacement.
Loose	A	Require repair or replacement.
Missing	C	Require replacement.
Resistance out of		

specification	B	.. Require repair or replacement.
Sensor housing cracked ..	2	.... Suggest replacement.
Terminal broken	A	.. Require repair or replacement.
Terminal burned, affecting performance	A	.... (2) Require repair or replacement.
Terminal burned, not affecting performance ..	2	.. Suggest repair or replacement.
Terminal corroded, affecting performance ..	A	.. Require repair or replacement.
Terminal corroded, not affecting performance ..	2	.. Suggest repair or replacement.
Terminal loose, affecting performance	B	.. Require repair or replacement.
Terminal loose, not affecting performance ..	1	.. Suggest repair or replacement.
Threads damaged	A	.. Require repair or replacement.
Threads stripped (threads missing)	A	.... Require replacement.
Wire lead conductors exposed	B	.. Require repair or replacement.
Wire lead corroded	A	.. Require repair or replacement.
Wire lead misrouted	B	.... Require re-routing according to vehicle manufacturer's specifications.
Wire lead open	A	.. Require repair or replacement.
Wire lead shorted	A	.. Require repair or replacement.

(1) - If a sensor is not adjustable, further inspection is required to identify and correct cause.
(2) - Determine cause and correct prior to repair or replacement of part.
(3) - Determine source of contamination, such as metal particles or water. Require repair or replacement.
(4) - Inoperative includes intermittent operation or out of OEM specification. Some components may be serviceable; check for accepted cleaning procedure.

SPEEDOMETER-DRIVEN GEAR HOUSINGS

See SPEEDOMETER/ODOMETER DRIVES (MECHANICAL).

SPEEDOMETER/ODOMETER DRIVES (MECHANICAL)

SPEEDOMETER/ODOMETER DRIVE (MECHANICAL) INSPECTION

Condition	Code	Procedure
Application incorrect ...	B	.... Require replacement.
Attaching hardware broken	A	... Require repair or replacement of hardware.
Attaching hardware missing	C	.... Require replacement of hardware.
Attaching hardware not functioning	A	... Require repair or replacement of hardware.
Inoperative	A	.... (1) Require replacement.
Leaking	A	.. Require repair or replacement.
Missing	C	.... Require replacement.
Teeth broken	A	.. Require repair or replacement.

Threads damaged	A	.. Require repair or replacement.
Threads stripped (threads missing)	A	.... Require replacement.
Worn close to the end of its useful life	1	.... Suggest replacement.
Worn, affecting performance	A	.... Require replacement.

(1) - Inoperative includes intermittent operation.

SPEEDOMETER/ODOMETER HEADS (MECHANICAL)

SPEEDOMETER/ODOMETER HEAD (MECHANICAL) INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	... Require repair or replacement of hardware.
Attaching hardware missing	C	.... Require replacement of hardware.
Attaching hardware not functioning	A	... Require repair or replacement of hardware.
Lens broken	A	.... (1) Require repair or replacement.
Lens cloudy	2	.... (1) Suggest repair or replacement.
Lens missing	C	.... (1) Require repair or replacement.
Malfunctioning	A	.... (2) Require repair or replacement.
Noisy	2	.. Suggest repair or replacement.
Threads damaged	A	.. Require repair or replacement.
Threads stripped (threads missing)	A	.... Require replacement.

(1) - If lens is available as a separate part, require replacement of lens only.
(2) - Includes inoperative, intermittent operation, failure to perform all functions, out of OEM specification, or out of range.

SPEEDOMETERS AND ODOMETERS (ELECTRONIC)

SPEEDOMETER AND ODOMETER (ELECTRONIC) INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	... Require repair or replacement of hardware.
Attaching hardware missing	C	.... Require replacement of hardware.
Attaching hardware not functioning	A	... Require repair or replacement of hardware.
Connector broken	A	.. Require repair or replacement.
Connector (Weatherpack		

type) leaking	A	.. Require repair or replacement.
Connector melted	A	.... (1) Require repair or replacement.
Connector missing	C	.... Require replacement.
Leaking	A	.... Require replacement.
Lens broken	A	.... (2) Require repair or replacement.
Lens cloudy	2	.... (2) Suggest repair or replacement.
Lens missing	C	.... (2) Require repair or replacement.
Malfunctioning	A	.... (3) Require repair or replacement.
Mechanical head noisy ...	2	.. Suggest repair or replacement.
Terminal broken	A	.. Require repair or replacement.
Terminal burned, affecting performance	A	.... (1) Require repair or replacement.
Terminal burned, not affecting performance ..	2	.. Suggest repair or replacement.
Terminal corroded, affecting performance ..	A	.. Require repair or replacement.
Terminal corroded, not affecting performance ..	2	.. Suggest repair or replacement.
Terminal loose, affecting performance	B	.. Require repair or replacement.
Terminal loose, not affecting performance ..	1	.. Suggest repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - If lens is available as a separate part, require replacement of lens only.
(3) - Includes inoperative, intermittent operation, failure to perform all functions, out of OEM specification, or out of range.

SWITCHES

SWITCH INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	... Require repair or replacement of hardware.
Attaching hardware missing	C	.... Require replacement of hardware.
Attaching hardware not functioning	A	... Require repair or replacement of hardware.
Binding, affecting performance	A	.. Require repair or replacement.
Binding, not affecting performance	2	.. Suggest repair or replacement.
Broken	A	.. Require repair or replacement.
Burned, affecting performance	A	.... (1) Require repair or replacement.
Burned, not affecting performance	2	.... (1) Suggest repair or

Condition	Code	Procedure
		replacement.
Cracked, affecting performance	A	Require repair or replacement.
Cracked, not affecting performance	1	Suggest repair or replacement.
Leaking	A	Require repair or replacement.
Malfunctioning	A	(2) Require repair or replacement.
Melted, affecting performance	A	(1) Require repair or replacement.
Melted, not affecting performance	2	(1) Suggest repair or replacement.
Missing	C	Require replacement.
Out of adjustment	B	Require repair or replacement.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(1) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.
Won't return	A	Require repair or replacement.
Worn	1	Suggest replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - Includes inoperative, intermittent operation, or failure to perform all functions.

TONE WHEELS

See TOOTHED RINGS (TONE WHEELS).

TOOTHED RINGS (TONE WHEELS)

If the toothed ring requires replacement and cannot be replaced as a separate component, replace the assembly of which the ring is a part.

TOOTHED RING (TONE WHEEL) INSPECTION

Condition	Code	Procedure
Alignment incorrect	B	Require repair or replacement.
Bent	B	Require replacement.
Contaminated, affecting performance	A	Require repair. Identify and correct cause.
Cracked	B	Require replacement.
Loose	A	Require replacement of worn parts.
Missing	C	Require replacement.
Number of teeth		

incorrect	B	Require replacement.
Teeth broken	A	Require replacement.
Teeth damaged, affecting performance	A	Require replacement.

TORQUE CONVERTERS

TORQUE CONVERTER INSPECTION

Condition	Code	Procedure
Converter clutch lock-up operation is faulty	A	Require replacement.
Cover shell damaged, affecting performance	A	Require replacement.
Does not meet stall speed specification	B	Require replacement.
End play exceeds specifications	B	Require replacement.
Hub broken	A	Require replacement.
Hub cracked	A	Require replacement.
Internal component failure	A	Require replacement.
Leaking	A	Require repair or replacement.
Pilot broken	A	Require replacement.
Pilot worn, affecting performance	A	Require replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.
Weights missing	C	Require replacement.

TRANSAXLE MOUNTS

See MOUNTS (ENGINE, TRANSAXLE AND TRANSMISSION).

TRANSDUCERS (TRANSMISSION)

See SENSORS.

TRANSMISSION COOLERS

TRANSMISSION COOLER INSPECTION

Condition	Code	Procedure
Air flow obstruction	A	Require repair.
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Connection leaking	A	Require repair or replacement.
Contaminated	A	Require repair or replacement.
Corroded	1	Suggest repair or replacement.
Fins damaged, affecting		

performance	A ..	Require repair or replacement.
Fins damaged, not affecting performance ..	.. ..	No service suggested or required.
Internal restrictions ...	B ..	Require repair or replacement.
Leaking	A ..	Require repair or replacement.
Threads damaged	A ..	Require repair or replacement.
Threads stripped (threads missing)	A ..	Require repair or replacement.
Tubes damaged, affecting performance	A ..	Require repair or replacement.
Tubes damaged, not affecting performance ..	.. ..	No service suggested or required.

TRANSMISSION MOUNTS

See MOUNTS (ENGINE, TRANSAXLE AND TRANSMISSION).

TRANSMISSION PANS

TRANSMISSION PAN INSPECTION

Condition	Code	Procedure
Bent, interfering with filter or other internal components	A ..	Require repair or replacement.
Leaking	A ..	Require repair or replacement.

TRANSMISSION RANGE INDICATORS (PRNDL)

TRANSMISSION RANGE INDICATOR (PRNDL) INSPECTION

Condition	Code	Procedure
Binding	A ..	Require repair or replacement.
Broken	A ..	Require repair or replacement.
Components missing	C ..	Require replacement of missing components.
Loose, affecting performance	A ..	Require repair or replacement.
Out of adjustment	A	Require repair.
Worn, affecting performance	A ..	Require repair or replacement.

TUBES

See HOSES, LINES AND TUBES.

UNIVERSAL JOINTS (CARDON OR CROSS TYPE)

UNIVERSAL JOINT (CARDON OR CROSS TYPE) INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A ...	Require repair or replacement of hardware.

Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Bearing cap distorted	B	Require replacement.
Binding	A	Require replacement.
Cross (trunion) worn, affecting performance	A	Require replacement.
Double cardon centering ball damaged	A	Require replacement.
Double cardon centering ball worn, affecting performance	A	Require replacement.
Double cardon centering spring broken	A	Require replacement.
Double cardon centering spring missing	C	Require replacement.
Double cardon centering spring weak	A	Require replacement.
End cap seal cracked	2	Suggest replacement.
End cap seal missing	C	Require replacement of seal.
Grease fitting broken	A	(1) Require replacement of grease fitting.
Grease fitting missing	C	(2) Require replacement of grease fitting.
Rust-colored powder around end cap seals	A	Require replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.
Worn, affecting performance	A	Require replacement.

(1) - A broken grease fitting does not require replacement of the U-Joint.
(2) - A missing grease fitting does not require replacement of the U-Joint.

VACUUM CONTROLS

See ACTUATORS (VACUUM).

VACUUM HOSES

See HOSES, LINES AND TUBES.

VACUUM MOTORS

See ACTUATORS (VACUUM).

VACUUM-OPERATED SWITCHES

See SWITCHES.

VEHICLE SPEED SENSORS

See SPEED SENSORS (ELECTRONIC WHEEL AND VEHICLE).

VENTS

VENT INSPECTION

Condition	Code	Procedure
Broken	A	Require replacement.
Missing	C	Require replacement.
Plugged	A	(1) Require repair or replacement.

(1) - A plugged vent may force fluid past the seal.

VIBRATION DAMPERS

VIBRATION DAMPER INSPECTION

Condition	Code	Procedure
Broken	A	Require replacement.
Missing	C	Require replacement.
Out of position	B	Require repair or replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.

WHEEL ATTACHMENT HARDWARE

NOTE: For conditions noted below, also check conditions of wheel stud holes.

CAUTION: Proper lug nut torque is essential. Follow recommended torque specifications and tightening sequence. DO NOT lubricate threads unless specified by the vehicle manufacturer.

WHEEL ATTACHMENT HARDWARE INSPECTION

Condition	Code	Procedure
Bent	A	Require replacement.
Broken	A	(1) Require replacement.
Loose	B	Require repair or replacement of affected component.
Lug nut installed backward	B	Require repair or replacement.
Lug nut mating surface dished	A	Require replacement of nut.
Lug nut mating type incorrect	B	Require replacement of nut.
Lug nut rounded	A	(2) Require replacement of nut.
Lug nut seized	A	(2) Require replacement of nut.
Stud incorrect	B	Require replacement of stud.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.

(1) - Some manufacturers require replacement of all studs on that wheel if two or more studs or nuts on the same wheel are broken or missing.
(2) - Only required if removing wheel.

WHEEL SPEED SENSORS

See SPEED SENSORS (ELECTRONIC WHEEL AND VEHICLE).

WIRING HARNESSES AND CONNECTORS

WIRING HARNESS AND CONNECTOR INSPECTION

Condition	Code	Procedure
Application incorrect	B	Require repair or replacement.
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Connector broken	A	Require repair or replacement.
Connector (Weatherpack type) leaking	A	Require repair or replacement.
Connector melted	A	(1) Require repair or replacement.
Connector missing	C	Require replacement.
Insulation damaged, conductors exposed	A	Require repair or replacement.
Insulation damaged, conductors not exposed	1	Suggest replacement.
Open	A	Require repair or replacement.
Protective shield (conduit) melted	2	(1) Suggest repair or replacement.
Protective shield (conduit) missing	2	Suggest repair or replacement.
Resistance (voltage drop) out of specification	A	Require repair or replacement.
Routed incorrectly	B	Require repair.
Secured incorrectly	B	Require repair.
Shorted	A	Require repair or replacement.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(1) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.
Transmission connector leaking	..	See TRANSMISSION ASSEMBLY.
Voltage drop out of specification	A	Require repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.

YOKES AND SLIP YOKES

YOKE AND SLIP YOKE INSPECTION

Condition	Code	Procedure
Bearing cap bore distorted	A	Require repair or replacement.
Bent	A	Require replacement.
Bolt holes elongated	A	Require repair or replacement.
Bushing or seal surface worn, affecting performance	A	Require repair or replacement.
Leaking through soft yoke plug	A	Require repair or replacement of soft yoke plug.
Retainer strap bent	A	Require replacement of retainer strap.
Slip yoke broken	A	Require replacement.
Splines worn, affecting performance	A	Require replacement.
Splines worn close to the end of their useful life	1	Suggest replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.
U-bolt damaged, affecting performance	A	Require replacement of U-bolts.
Yoke damaged, affecting performance	A	Require repair or replacement.

EGR FUNCTION TESTING

1988 Jeep Cherokee

1983-88 Exhaust Emission Systems
JEEP EXHAUST GAS RECIRCULATION

TESTING

EGR VALVE

Valve Opening Test

1) With engine at normal operating temperature and at idle, rapidly open and close throttle. Open throttle sufficiently to obtain at least 1500 RPM. Movement should be noticed in EGR diaphragm.

2) If diaphragm does not move, probable causes are: faulty vacuum signal to EGR, defective EGR diaphragm or defective backpressure sensor diaphragm (if equipped), or leaks in vacuum lines or connections.

Valve Closing Test

1) With engine at normal operating temperature and at idle, manually depress EGR valve diaphragm. RPM should immediately drop, indicating that EGR valve is not leaking and had been properly cutting off exhaust gas flow at idle.

2) If there is no change in RPM and engine is idling properly, exhaust gases are not reaching combustion chamber. Check for plugged passage between EGR valve and intake manifold.

3) If engine idles poorly and RPM is not greatly affected by manually moving diaphragm up, EGR valve is not closing off exhaust gas flow. Check for carbon between pintle, leaking EGR valve gasket or bad EGR valve.

COOLANT TEMPERATURE OVERRIDE (CTO) SWITCH

NOTE: Engine coolant temperature must be below 100°F (38°C) to perform this test.

1) Check vacuum lines for leaks and correct routing. Disconnect vacuum line at backpressure sensor (if equipped) or at EGR valve, and attach this line to vacuum gauge.

2) Operate engine at 1500 RPM. No vacuum should be indicated on gauge. If vacuum is shown, replace CTO switch.

3) Idle engine until coolant temperature exceeds 100°F (38°C) on 4-cylinder engines, or 115°F (46°C) on 6-cylinder and V8 engines.

4) Raise engine speed to 1500 RPM. Ported vacuum should be shown on gauge. If not, replace CTO switch.

DUMP VALVE

1) With engine at normal operating temperature, remove dump valve vacuum hose from manifold and plug manifold connection.

2) Raise engine speed to 2000 RPM. Vacuum should be present at exhaust ports on bottom of valve. If not, replace valve.

3) Reconnect vacuum hose to manifold and raise engine speed to 2000 RPM. No vacuum should be felt at exhaust ports on bottom of valve. If vacuum is present, replace valve.

THERMAL VACUUM SWITCH (TVS)

1) With the air cleaner temperature below 40°F (-4°C), disconnect vacuum hoses from TVS and connect vacuum source to large

outlet.

2) Apply vacuum to TVS. TVS should hold vacuum. If not, replace TVS.

3) Start engine and warm air cleaner to 55°F (13°C), or greater. TVS should not hold vacuum. If it does, replace TVS.

EGR SYSTEM

1988 Jeep Cherokee

1983-88 Exhaust Emission Systems
JEEP EXHAUST GAS RECIRCULATION

DESCRIPTION

Purpose of the Exhaust Gas Recirculation (EGR) system is to limit formation of oxides of nitrogen (NOx) emissions. This is done by reducing high peak combustion temperatures at which NOx is formed. By reintroducing some exhaust gas back into combustion chamber, high temperatures are avoided. Thus NOx emissions formation is reduced.

System consists of vacuum-operated EGR valve and coolant temperature override (CTO) switch. In addition, some models are equipped with air cleaner-mounted thermal vacuum switch (TVS), and some are equipped with an EGR vacuum dump valve.

OPERATION

When the EGR valve receives vacuum signal, through the CTO switch, EGR valve opens and meters gases from exhaust manifold into intake manifold. Individual component operation is as follows:

EGR VALVE

EGR valve is mounted on intake manifold. Exhaust gas is drawn from exhaust crossover passage or exhaust manifold. Two types of EGR valves are used: valve without backpressure sensor and valve with integral backpressure sensor.

EGR Valve W/O Integral Backpressure Sensor

EGR valves are calibrated by use of different shapes of valve pintles or orifices. Valve is normally held closed by spring (above diaphragm). Valve opens by overcoming spring tension when vacuum is sensed through coolant temperature override switch (CTO) and backpressure sensor (if equipped).

EGR Valve W/Integral Backpressure Sensor

Calibration is accomplished by use of different diaphragm spring loads and flow control orifices. This integral type unit combines EGR valve and backpressure sensor functions into one component. Restrictor plate is required with some engines.

Exhaust gas exerts backpressure inside exhaust manifold whenever engine is running. This pressure is conducted through hollow pintle stem into EGR diaphragm control chamber. If this pressure is great enough to overcome spring tension against diaphragm, diaphragm is moved against bleed valve and exhaust gas flow begins.

COOLANT TEMPERATURE OVERRIDE (CTO) SWITCH

Coolant temperature override (CTO) switch is located in coolant passage at cylinder head or coolant passage at intake manifold.

Inner port of switch is connected to EGR port on intake manifold and outer port is connected to EGR valve, or EGR-TVS. Switch opens at a preset temperature. Below these temperatures, no EGR is possible.

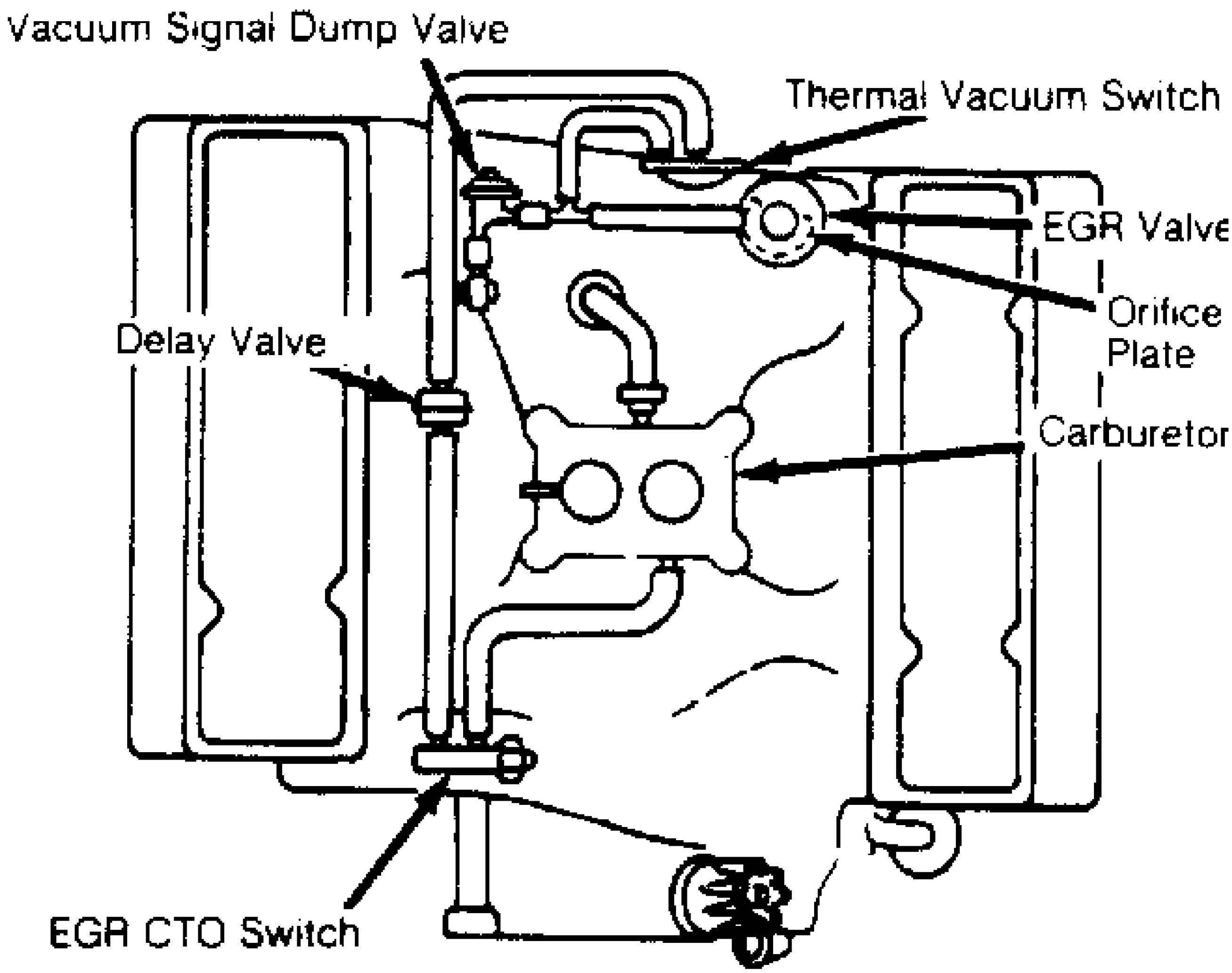


Fig. 1: Jeep V8 Carbureted Engine EGR System
Courtesy of Chrysler Motors.

THERMAL VACUUM SWITCH (TVS)

Used only on carbureted 6-cylinder and V8 engines, this switch is located in air cleaner and acts as on-off switch for EGR system. It is controlled by ambient temperature in air cleaner. Switch controls vacuum passage between CTO switch and EGR valve. Below preset temperature, TVS blocks passage of vacuum delaying EGR operation and improving cold driveability.

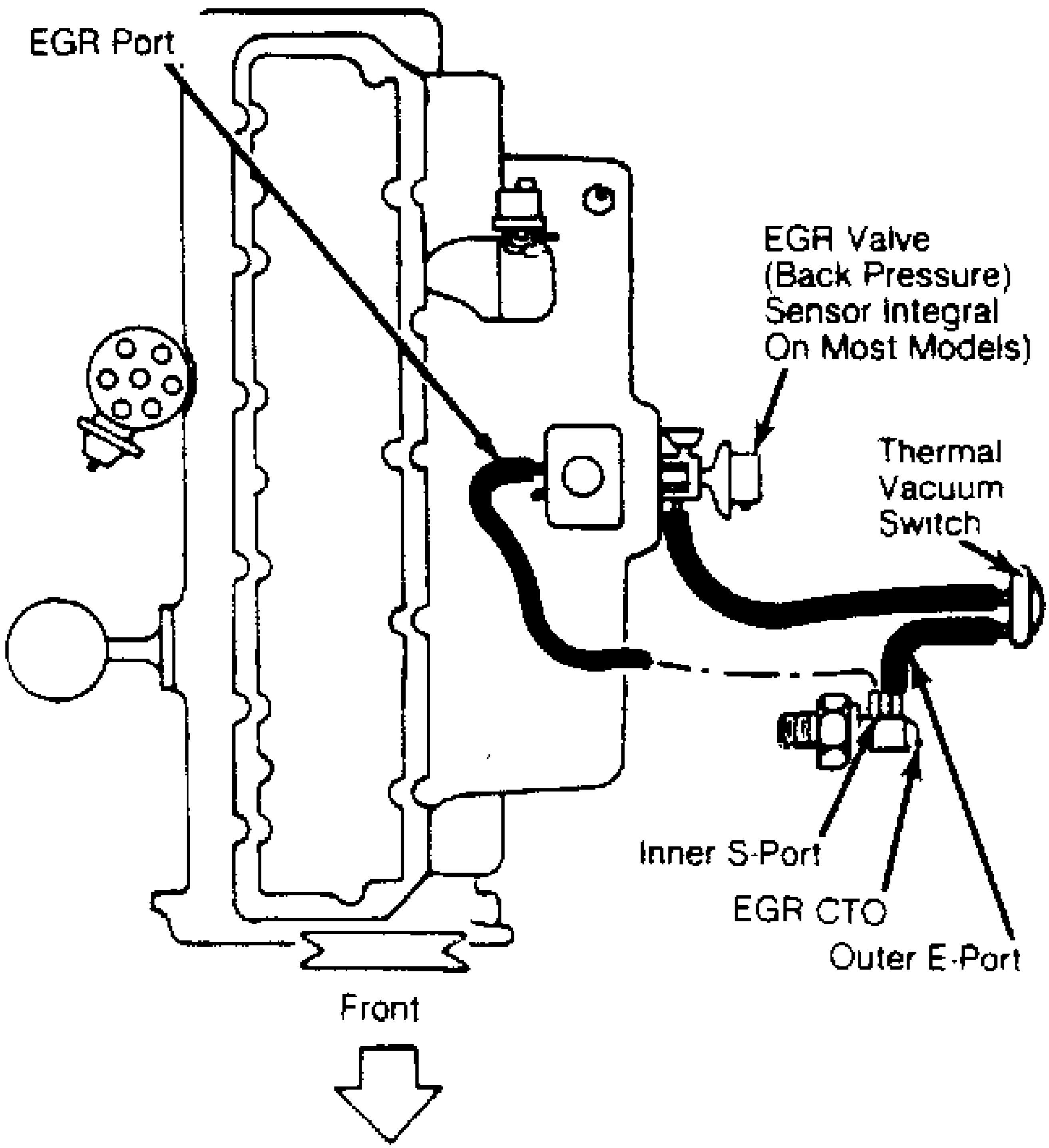


Fig. 2: Jeep 6-Cylinder Carbureted Engine EGR System
Courtesy of Chrysler Motors.

EGR DUMP VALVE

Used on some models, EGR dump valve is connected in series with vacuum source and EGR valve. Valve is used to eliminate EGR function at low vacuum levels. When vacuum drops below predetermined level, valve "dumps" vacuum rather than allowing it to flow to EGR

valve.

FORWARD DELAY VALVE

Forward delay valve is located between EGR CTO switch and EGR valve. It modifies initial vacuum signal applied to EGR valve by delaying full vacuum force.

TESTING

EGR VALVE

Valve Opening Test

1) With engine at normal operating temperature and at idle, rapidly open and close throttle. Open throttle sufficiently to obtain at least 1500 RPM. Movement should be noticed in EGR diaphragm.

2) If diaphragm does not move, probable causes are: faulty vacuum signal to EGR, defective EGR diaphragm or defective backpressure sensor diaphragm (if equipped), or leaks in vacuum lines or connections.

Valve Closing Test

1) With engine at normal operating temperature and at idle, manually depress EGR valve diaphragm. RPM should immediately drop, indicating that EGR valve is not leaking and had been properly cutting off exhaust gas flow at idle.

2) If there is no change in RPM and engine is idling properly, exhaust gases are not reaching combustion chamber. Check for plugged passage between EGR valve and intake manifold.

3) If engine idles poorly and RPM is not greatly affected by manually moving diaphragm up, EGR valve is not closing off exhaust gas flow. Check for carbon between pintle, leaking EGR valve gasket or bad EGR valve.

COOLANT TEMPERATURE OVERRIDE (CTO) SWITCH

NOTE: Engine coolant temperature must be below 100°F (38°C) to perform this test.

1) Check vacuum lines for leaks and correct routing. Disconnect vacuum line at backpressure sensor (if equipped) or at EGR valve, and attach this line to vacuum gauge.

2) Operate engine at 1500 RPM. No vacuum should be indicated on gauge. If vacuum is shown, replace CTO switch.

3) Idle engine until coolant temperature exceeds 100°F (38°C) on 4-cylinder engines, or 115°F (46°C) on 6-cylinder and V8 engines.

4) Raise engine speed to 1500 RPM. Ported vacuum should be shown on gauge. If not, replace CTO switch.

DUMP VALVE

1) With engine at normal operating temperature, remove dump valve vacuum hose from manifold and plug manifold connection.

2) Raise engine speed to 2000 RPM. Vacuum should be present at exhaust ports on bottom of valve. If not, replace valve.

3) Reconnect vacuum hose to manifold and raise engine speed to 2000 RPM. No vacuum should be felt at exhaust ports on bottom of valve. If vacuum is present, replace valve.

THERMAL VACUUM SWITCH (TVS)

1) With the air cleaner temperature below 40°F (-4°C), disconnect vacuum hoses from TVS and connect vacuum source to large outlet.

2) Apply vacuum to TVS. TVS should hold vacuum. If not, replace TVS.

3) Start engine and warm air cleaner to 55°F (13°C), or greater. TVS should not hold vacuum. If it does, replace TVS.

ELECTRICAL COMPONENT LOCATOR

1988 Jeep Cherokee

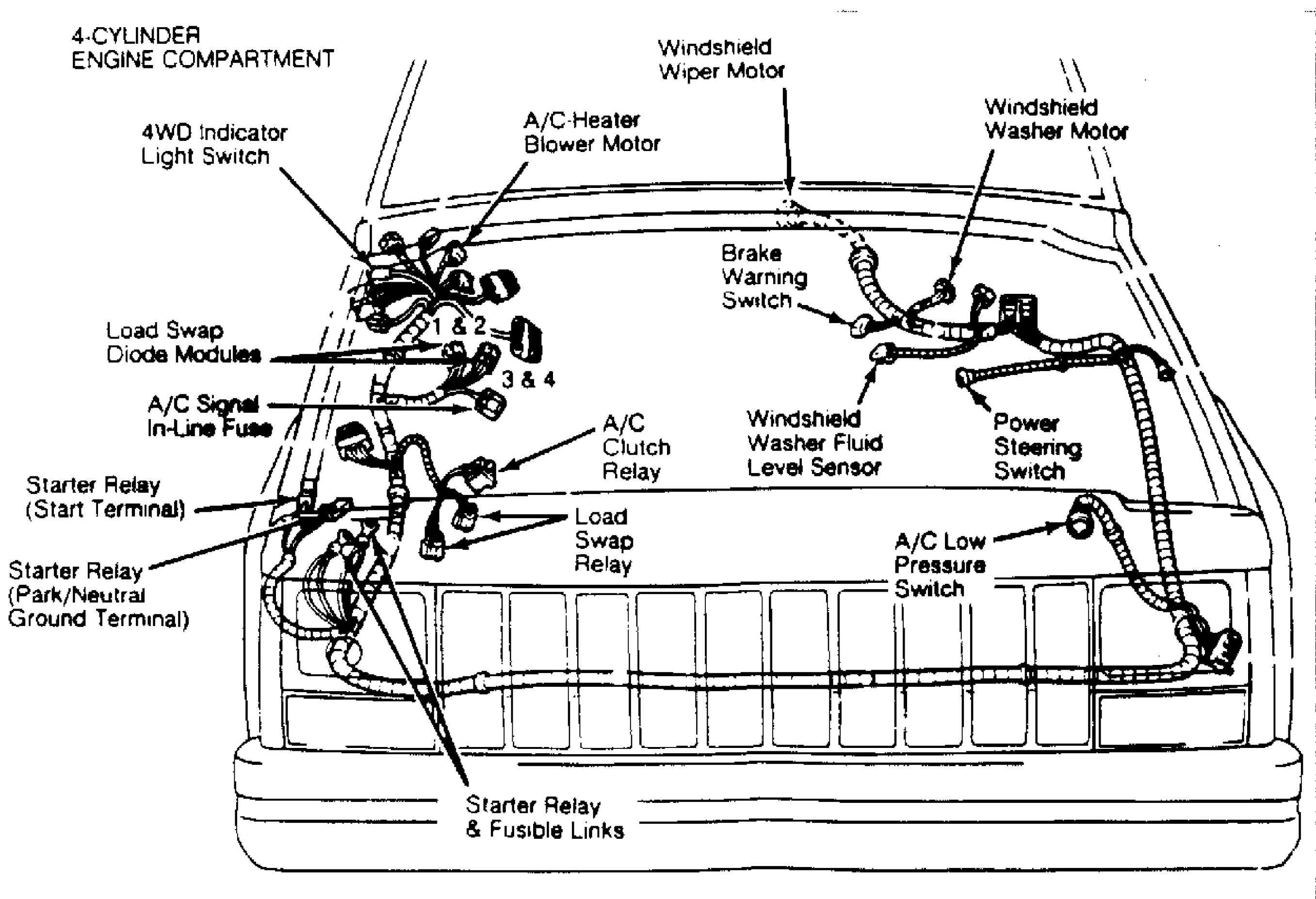
1988 ELECTRICAL COMPONENT LOCATOR
Jeep Electrical Component Locations

Cherokee, Comanche & Wagoneer

COMPONENT LOCATOR CHARTS

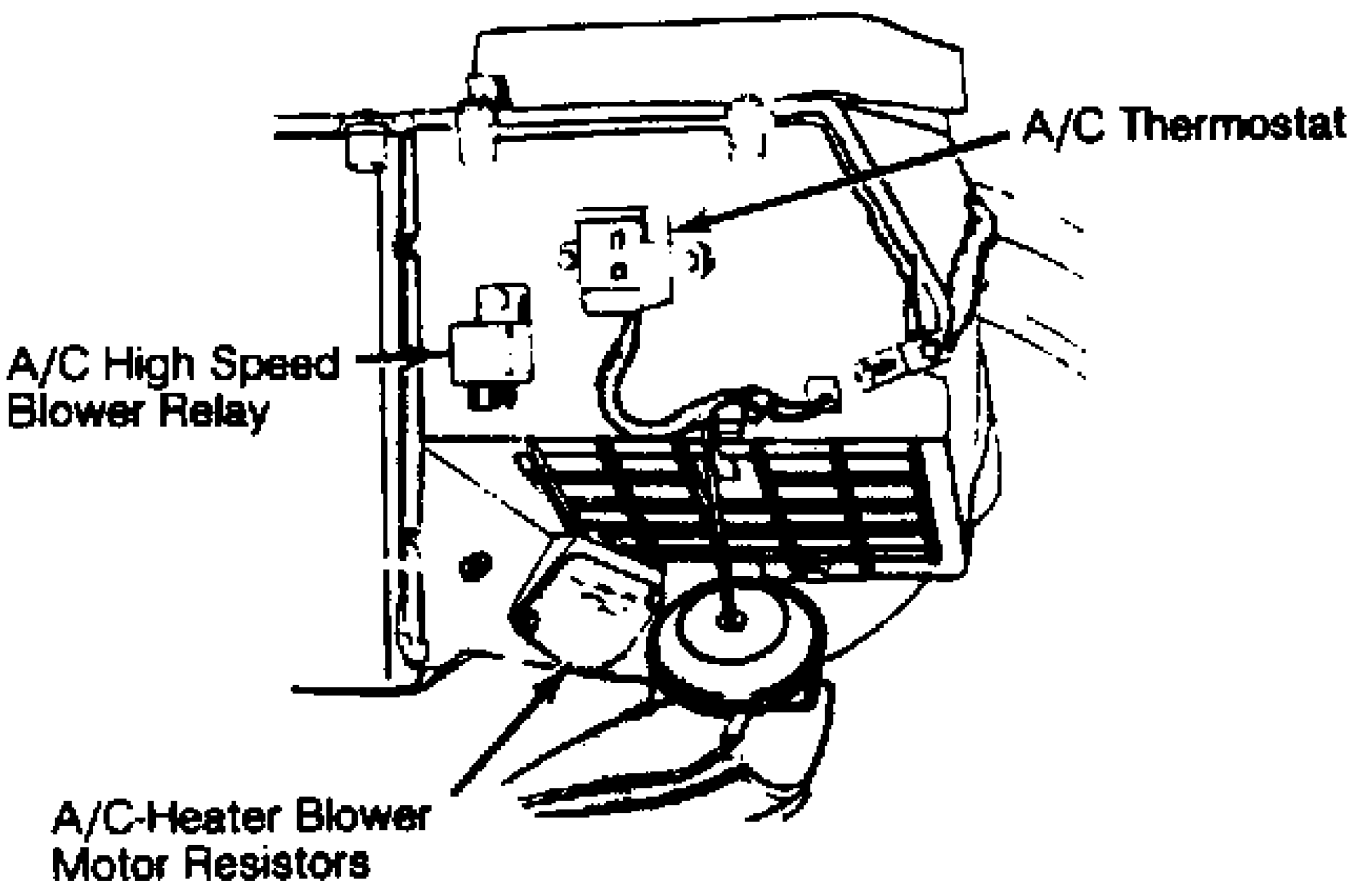
BUZZERS, RELAYS & TIMERS

Component	Component Location

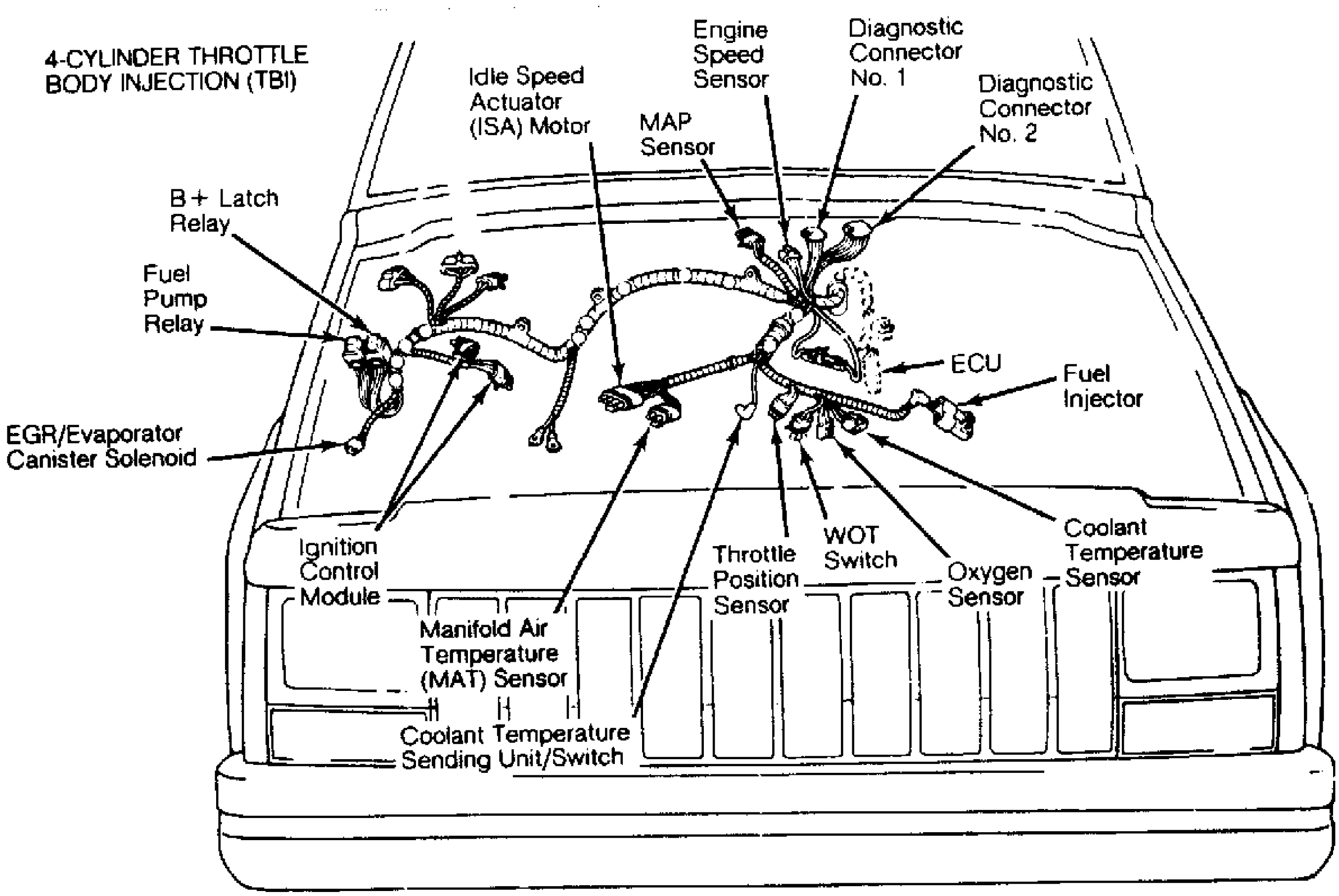


A/C Clutch Relay	On right front wheelwell.

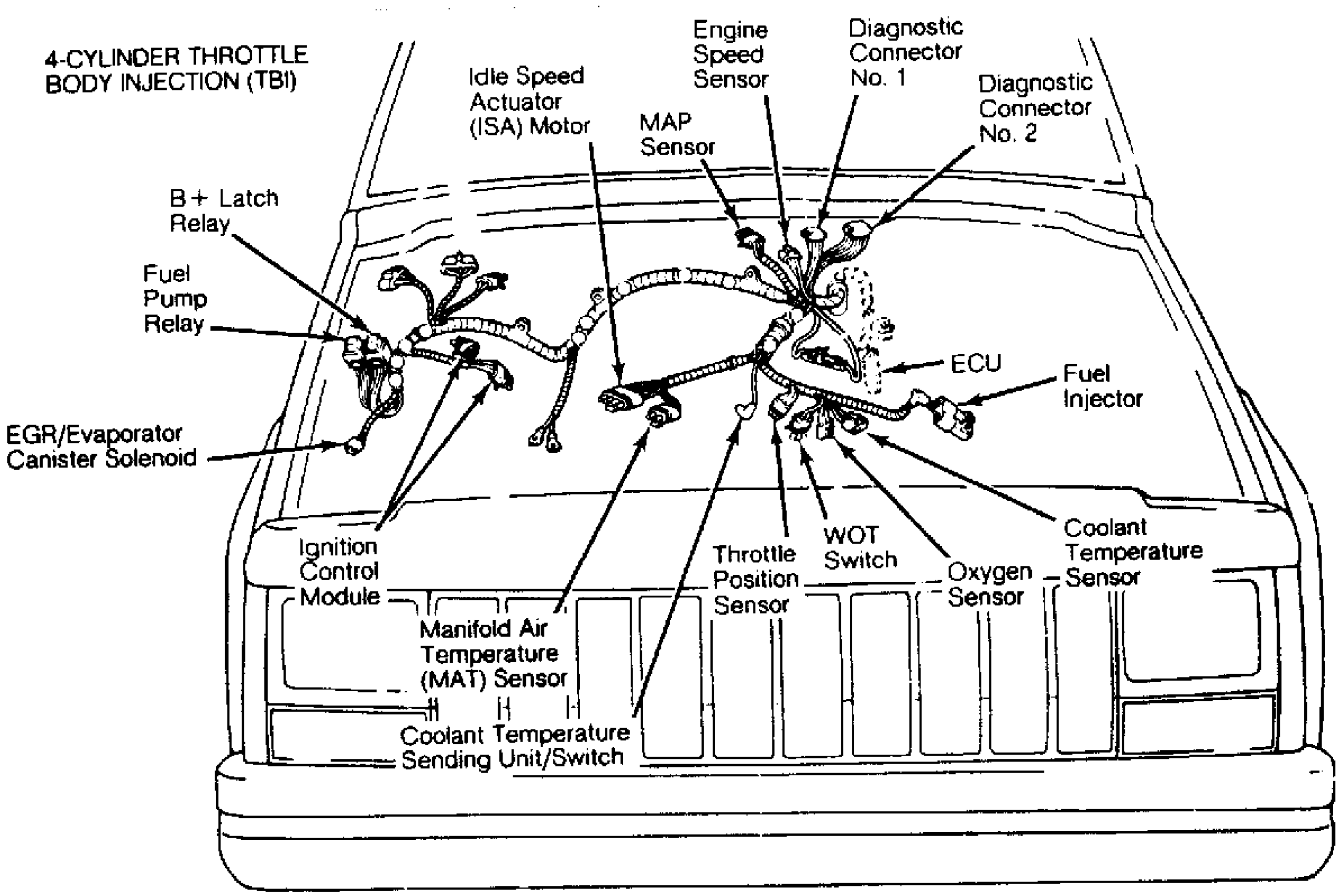
GASOLINE



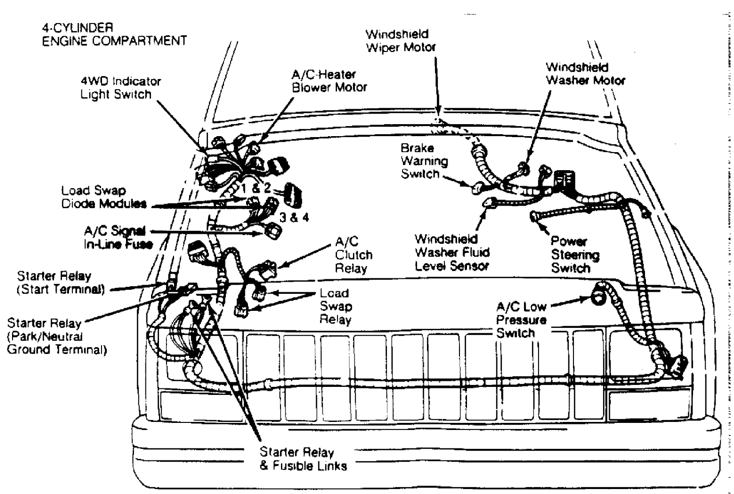
A/C-Heater Blower Relays	Under right side of dash, on evaporator housing.
Automatic Load Leveling Relay	On load level compressor bracket.



B+ Latch Relay	On center of right front wheelwell.
Choke Relay	On right front wheelwell.
Door Lock/Unlock Relays	Under dash, behind right kick panel.
Fog Light Relay	Behind right headlight, on wheelwell.

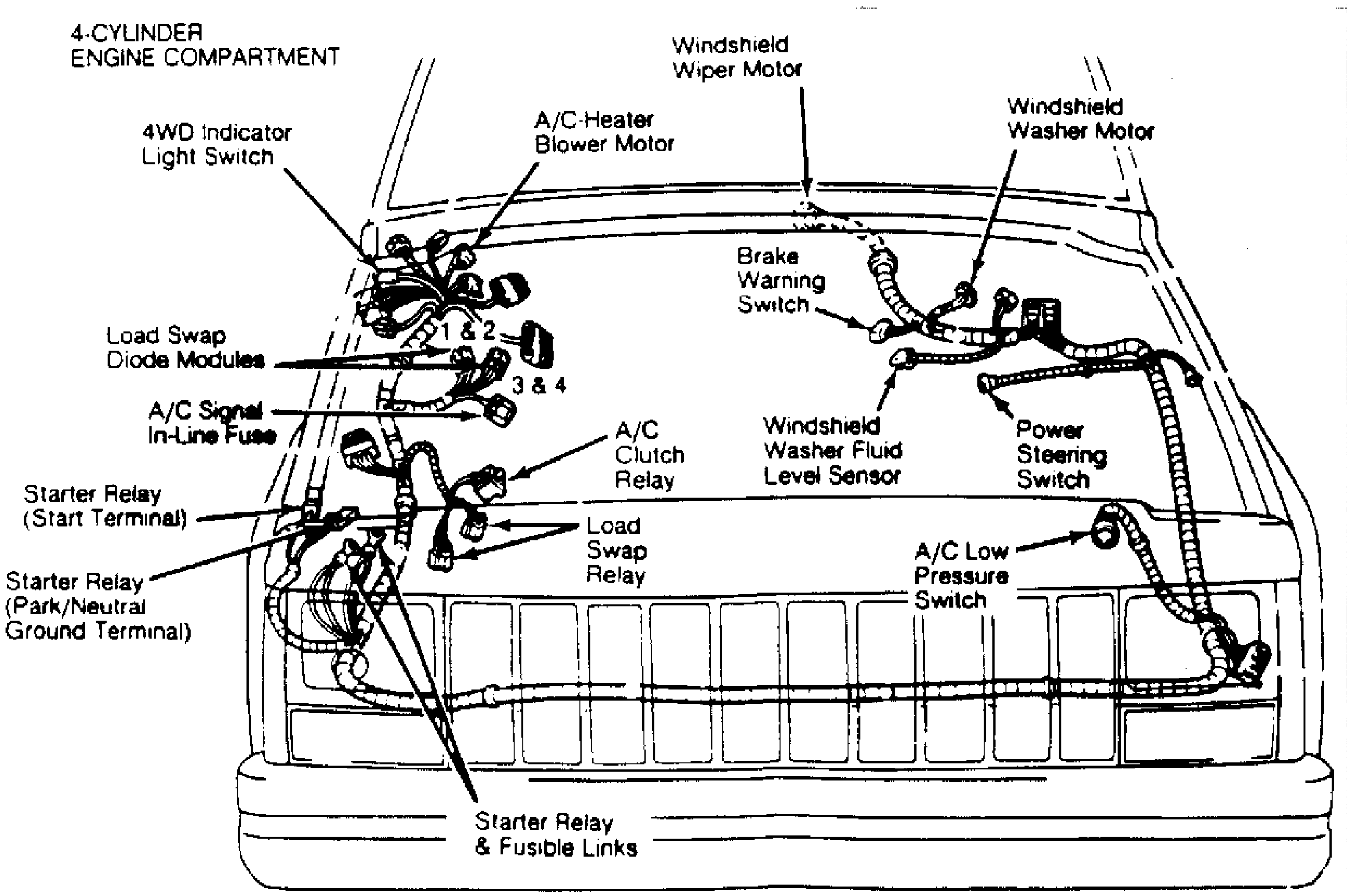


Fuel Pump Relay	On right front wheelwell.
Horn Relay	Taped to wiring harness, above fuse block.

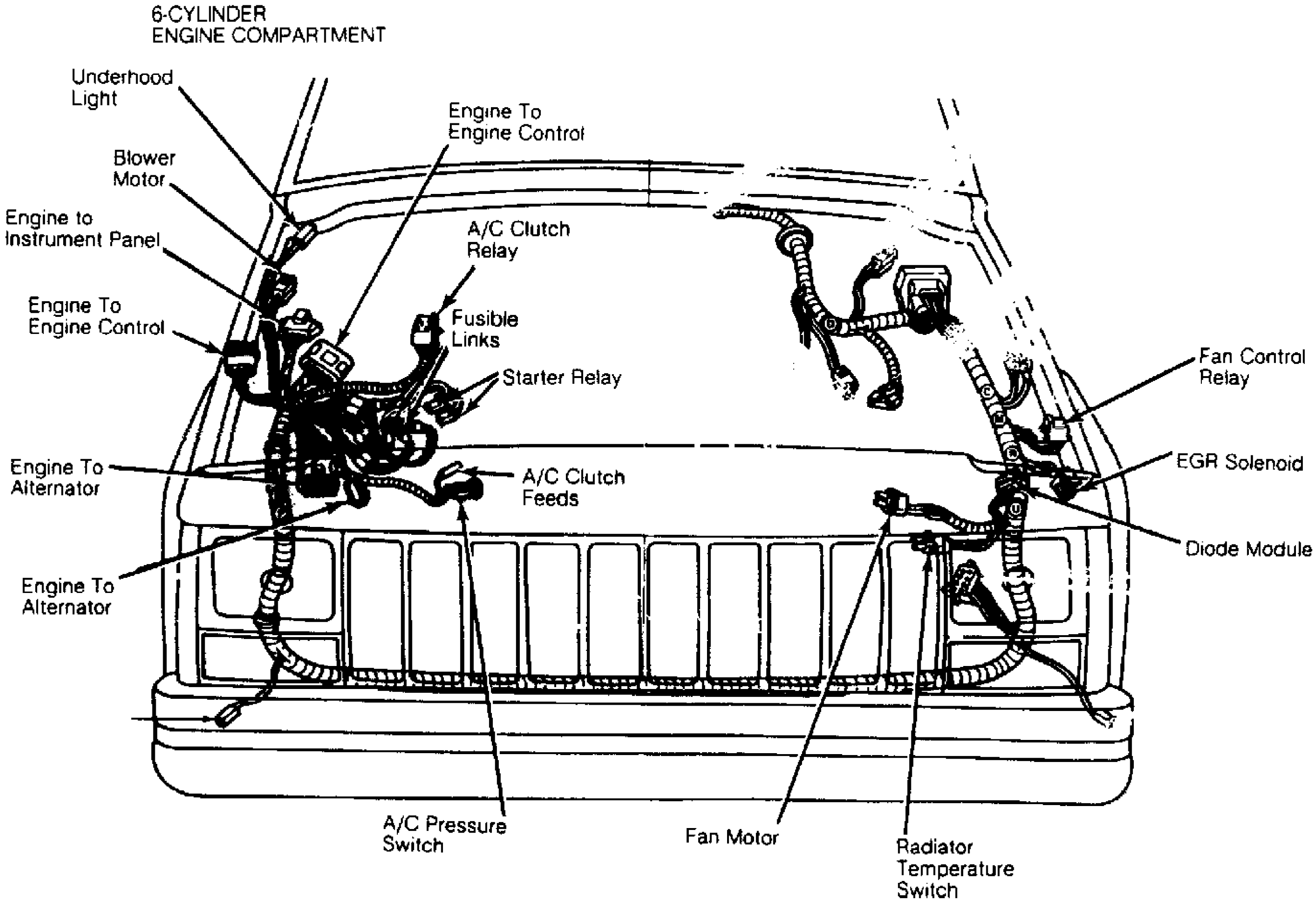


Load Swap Relay	On front of right front wheelwell.
Power Antenna Relay	Under right side of dash.

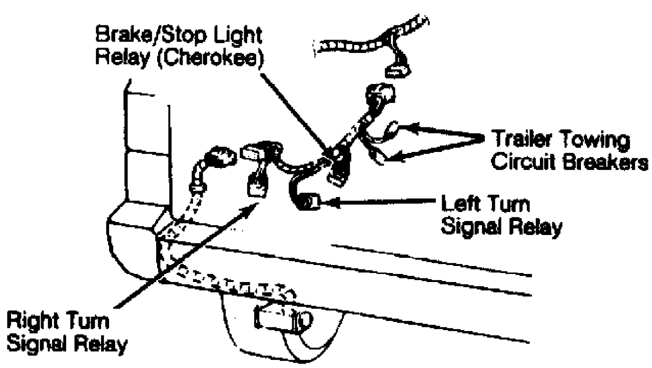
Rear Window Defogger Relay	Under instrument panel, to right of steering column.
Rear Wiper Relay	In tailgate, next to wiper motor.



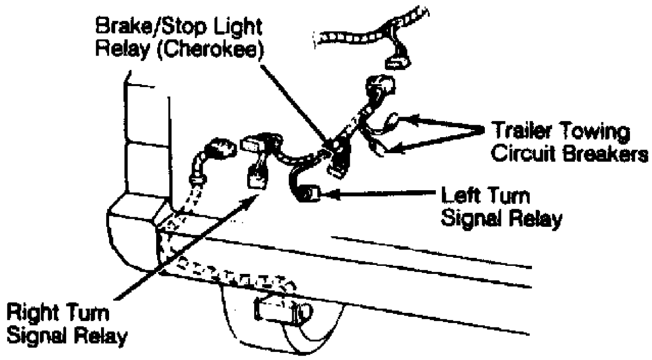
Starter Relay (Graphic 1)	Behind right headlight, on wheelwell.



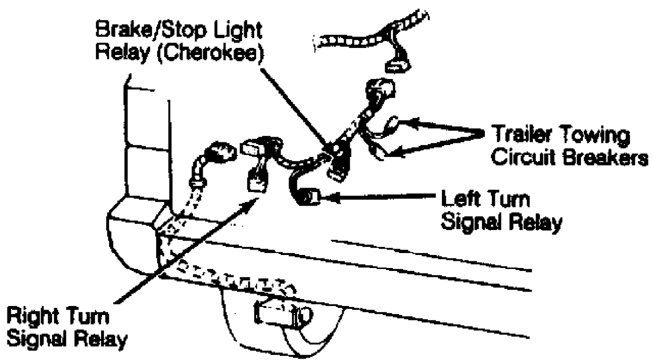
Starter Relay (Graphic 2)	Behind right headlight, on wheelwell.
Timer Delay Relay	Above starter relay, behind battery.



Trailer Towing Relays, Brake/Stop Light Relay (Cherokee)	Above left rear wheelwell.



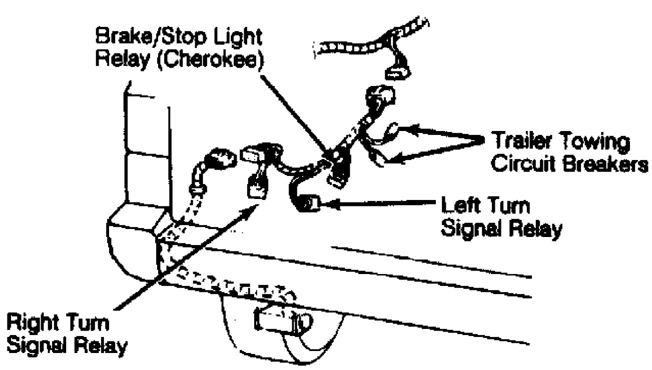
Left Turn Signal Relay	Above left rear wheelwell.



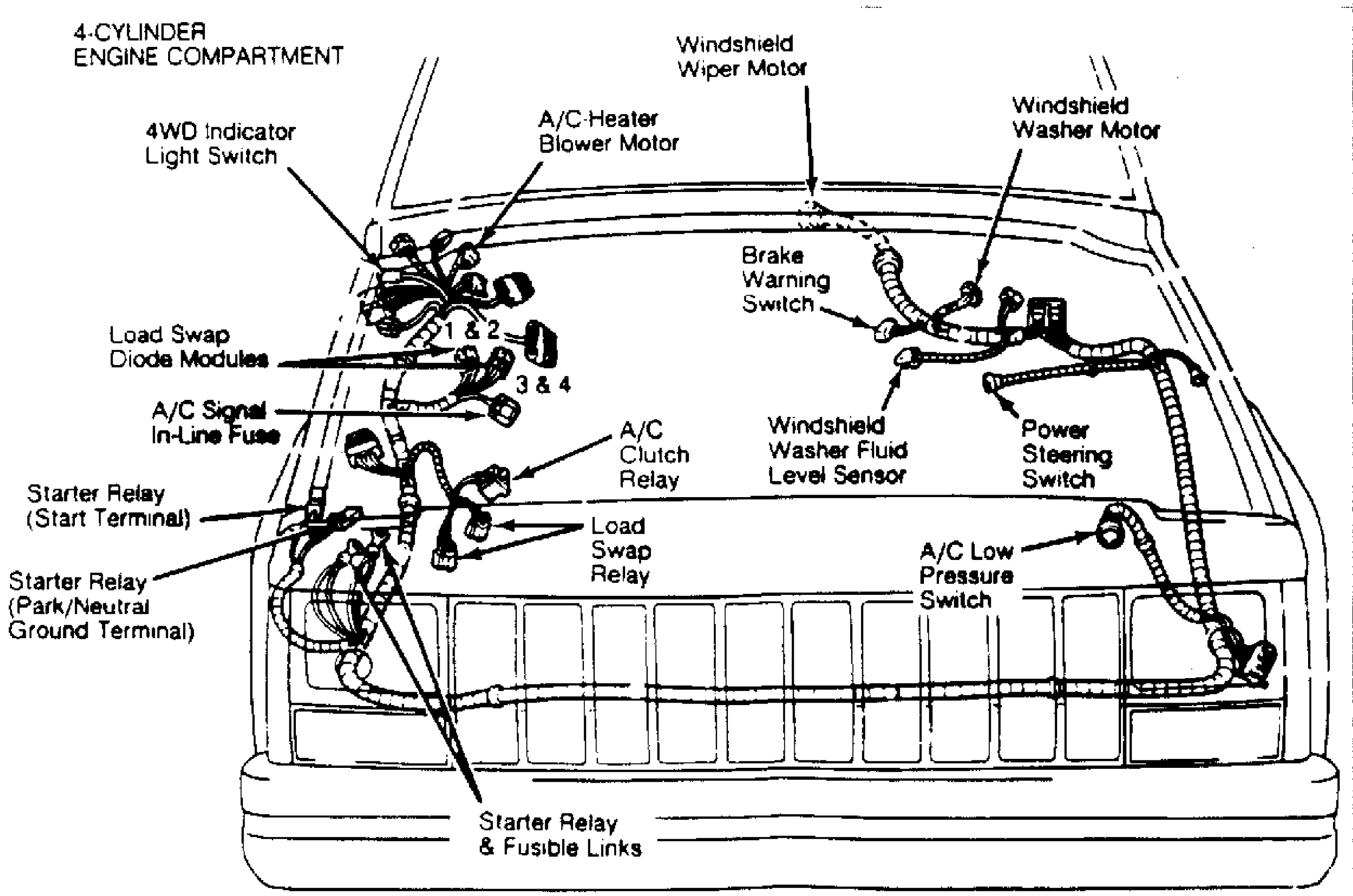
Right Turn Signal Relay	Above left rear wheelwell.

CIRCUIT PROTECTION DEVICES

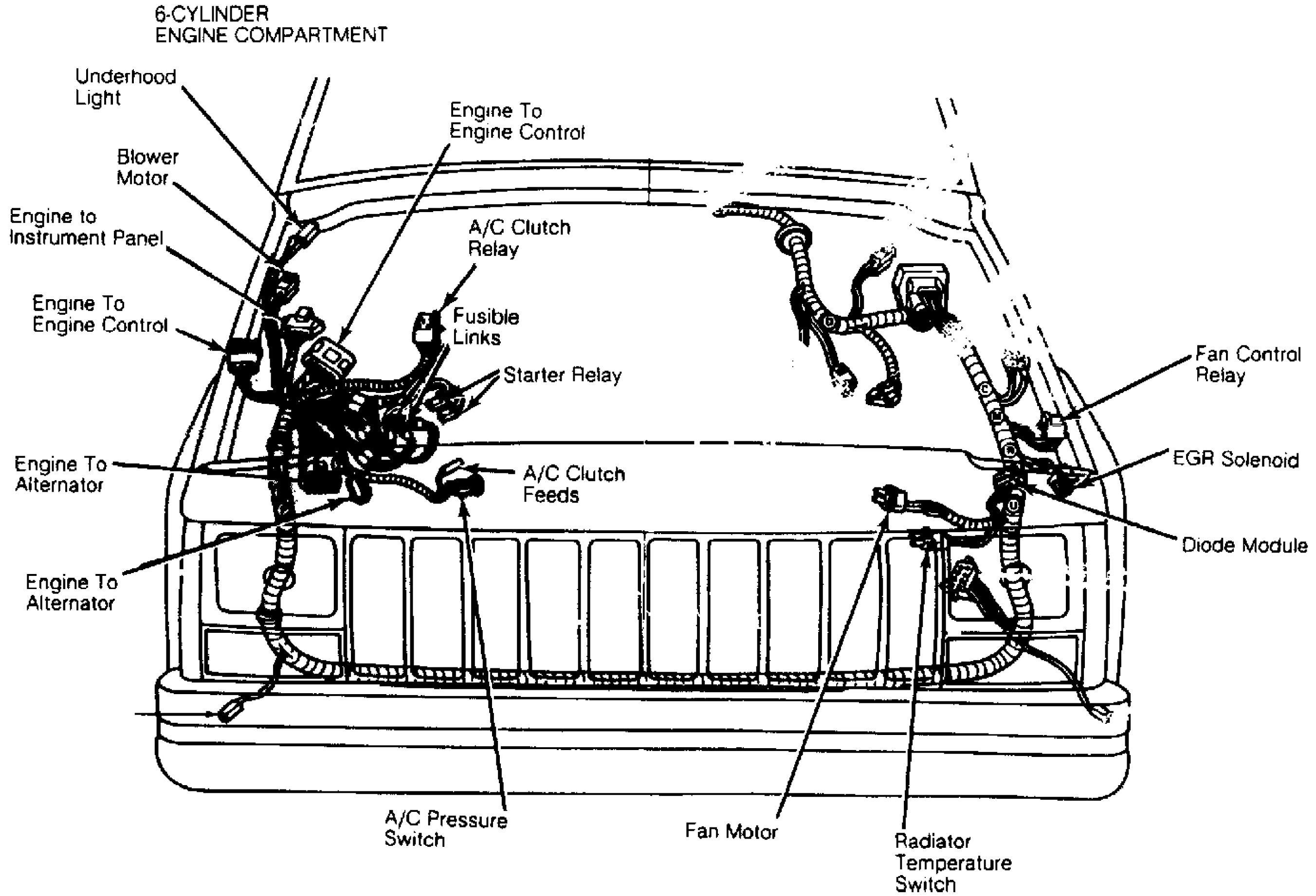
Component	Component Location
Circuit Breakers	
Power Accessories	In fuse block.
Power Window	In fuse block.



Trailer Towing	Above left rear wheelwell.
Windshield Wiper	On side of fuse block.
Fuse Block	Under left side of dash.

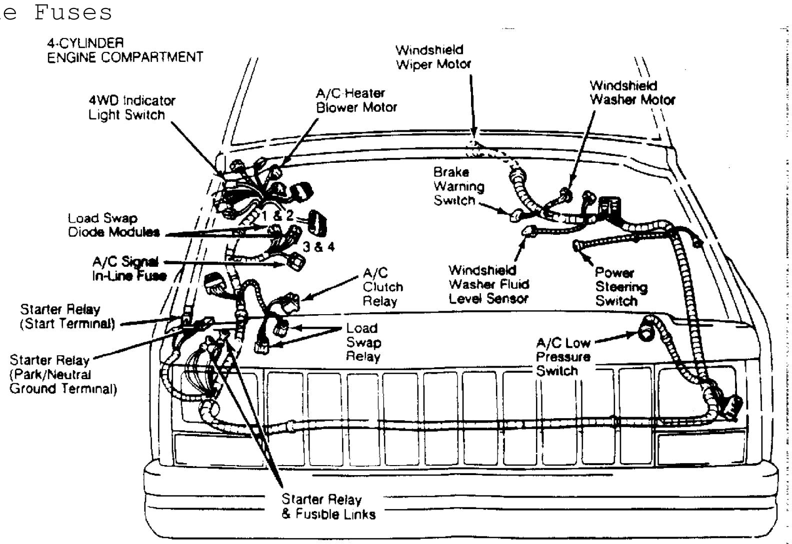


Fusible Links (Graphic 1)   At starter relay.



Fusible Links (Graphic 2) At starter relay.

In-Line Fuses

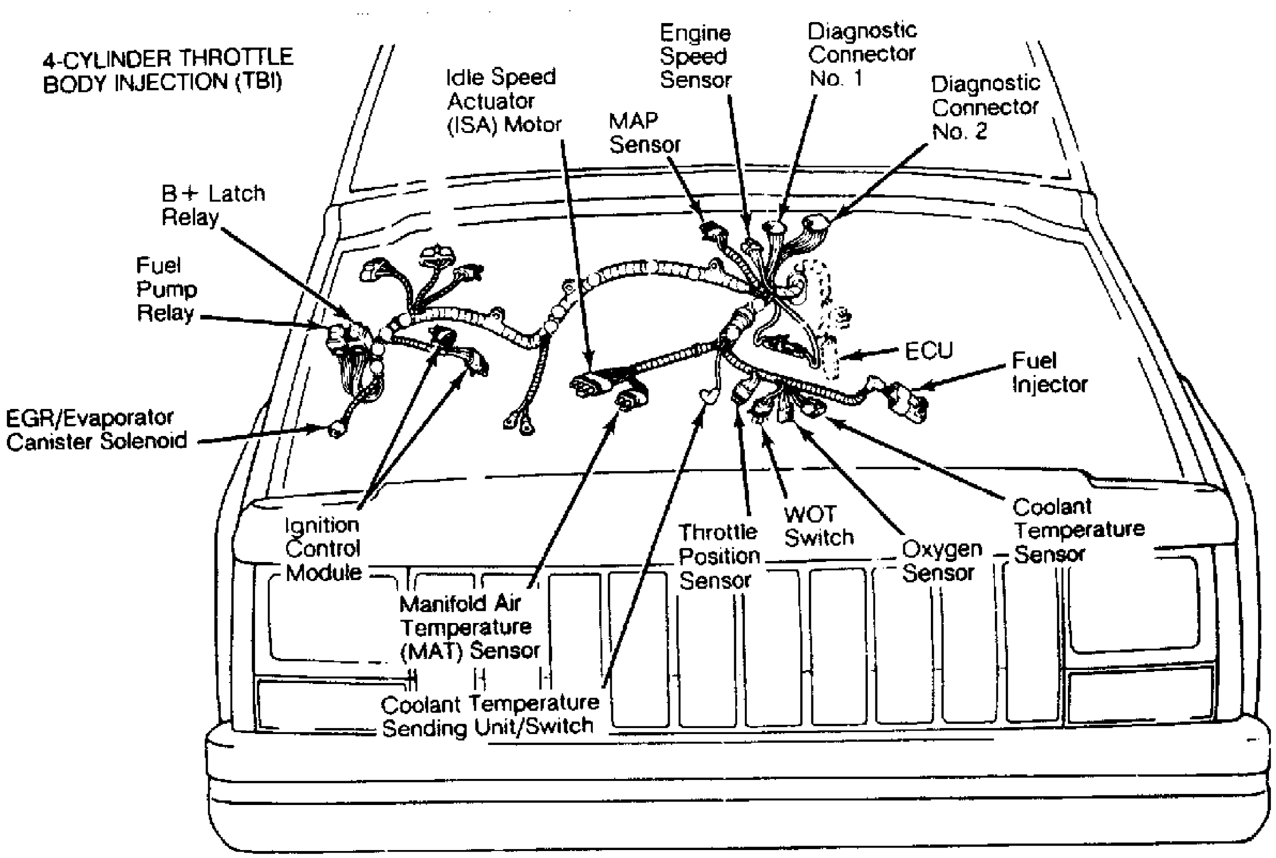


A/C Signal Fuse	Near diode modules or above left front wheelwell.
Fuses A & B	Taped to engine wiring harness, near thermo-electric

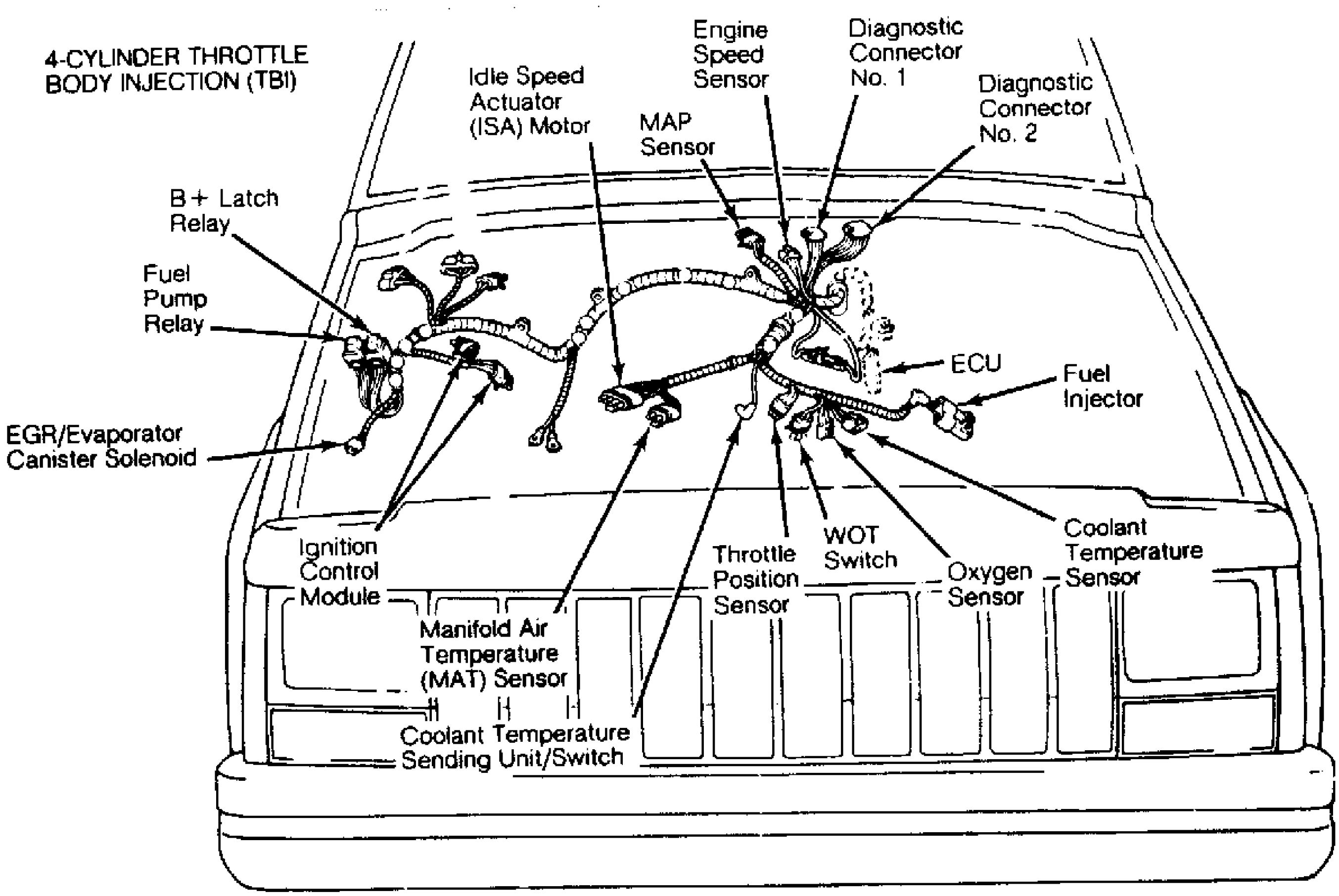
	switch.
Fuse C	Taped to engine wiring harness, by alternator.
Fuse D	Taped to engine wiring harness, near power steering switch.
Cruise Control	Under left side of dash, near brake pedal.
Radio	Under center of dash, behind radio.

CONTROL UNITS

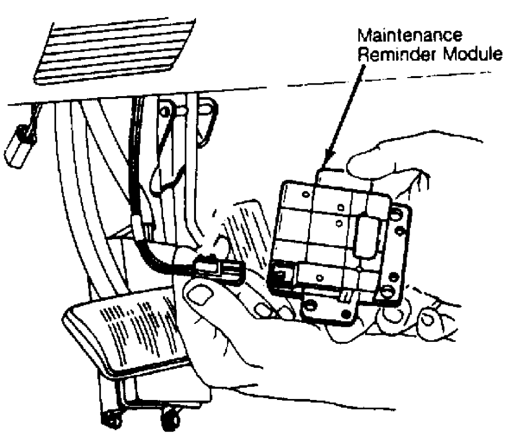
Component	Component Location
Audio Alarm Module	On side of fuse block.
Cruise Control Regulator Module	Under dash, above brake pedal.



Elect. Control Unit (ECU)	Under dash, above accelerator pedal.

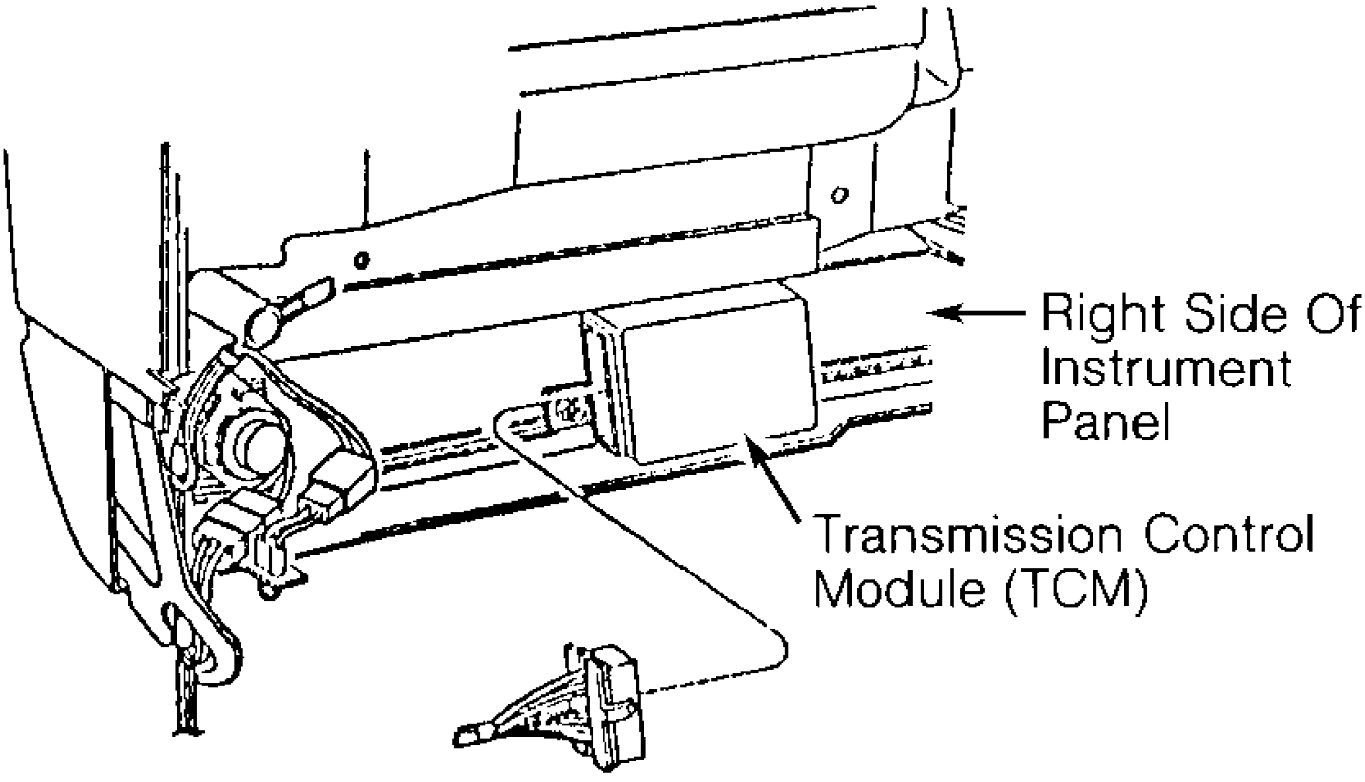


Ignition Control Module	In engine compartment, on right wheelwell.
Intermittent Wiper Module	Under left side of dash, above brake pedal.
Keyless Entry Receiver	Between sun visors.



Maint. Reminder Module	Under dash, to right of steering column.
Sentinel Light Module	Under left side of dash, near headlight switch.

System Sentry Control Module — Under dash, to right of steering column.

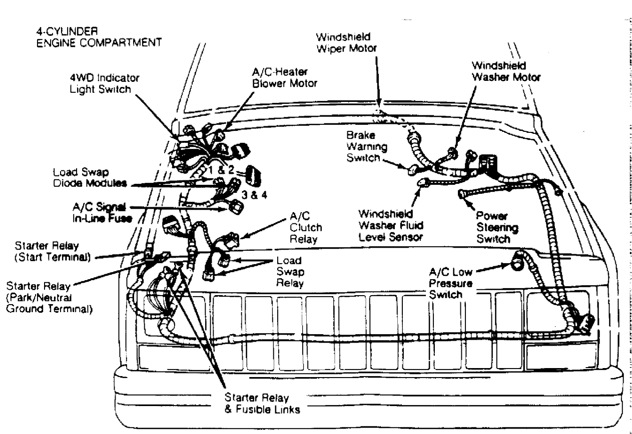


94F38401

Transmission Control Module — Under right side of instrument panel.

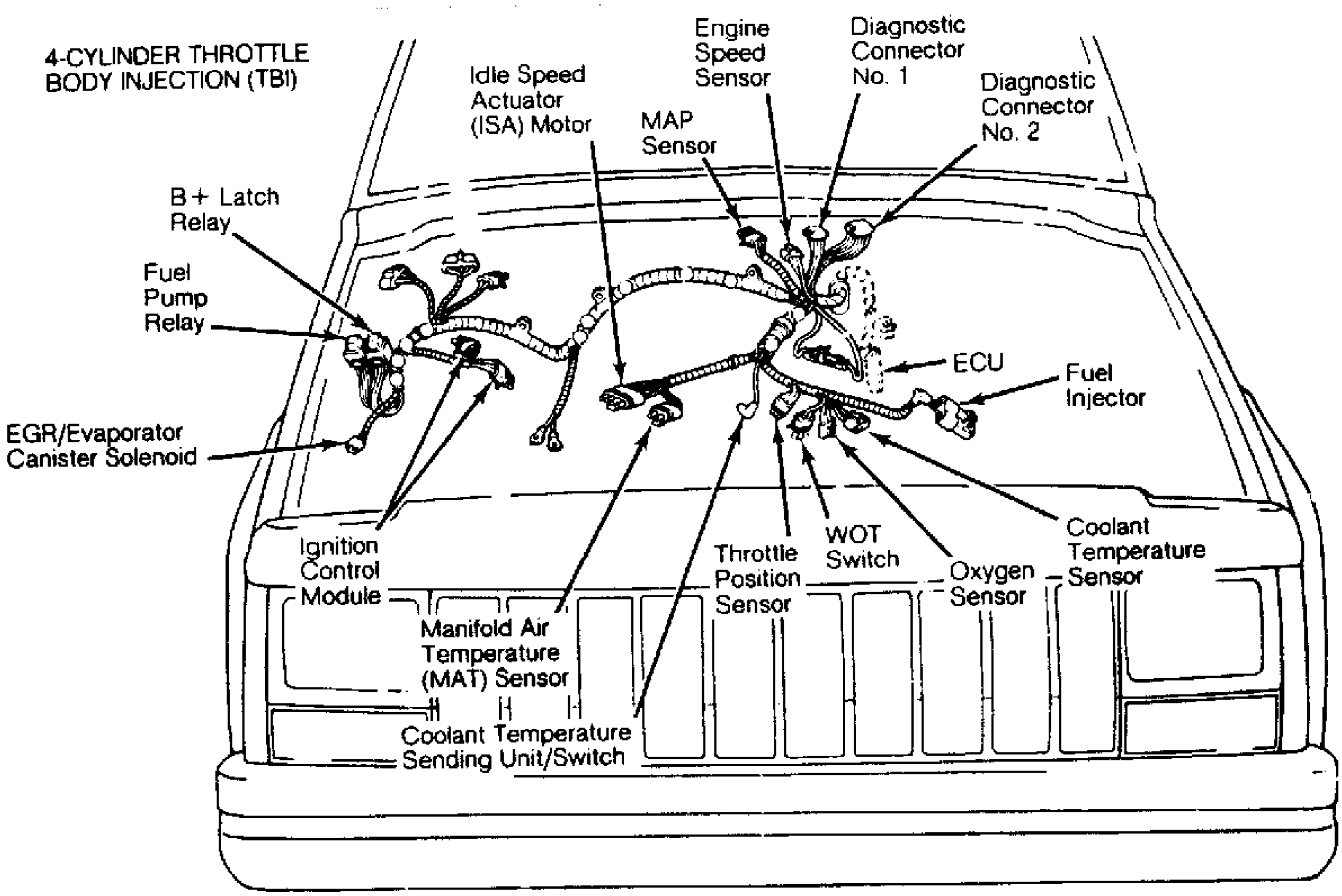
MOTORS

Component	Component Location

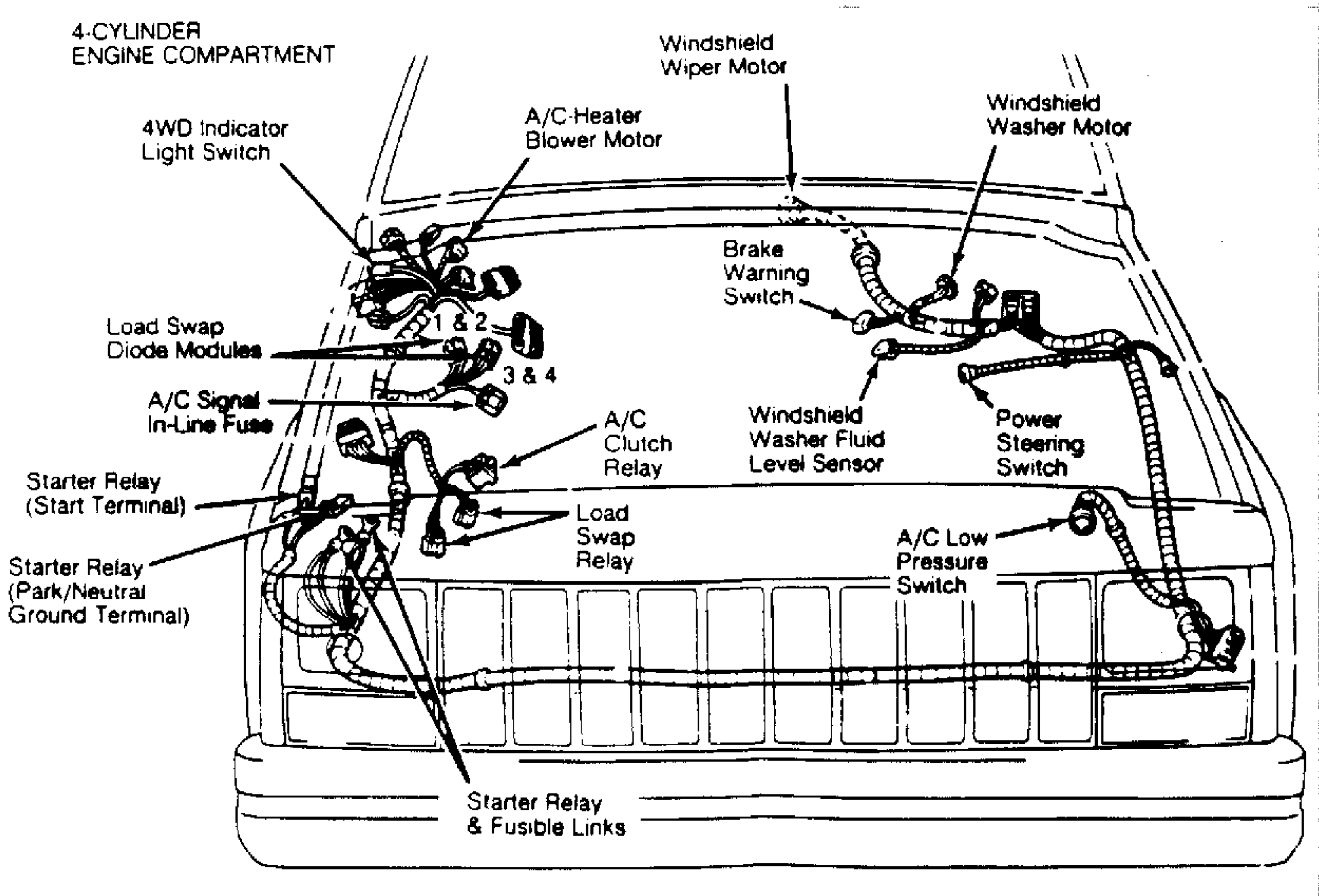


A/C-Heater Blower Motor	In evaporator housing.

Automatic Load Level Compressor	In right rear corner of engine compartment.

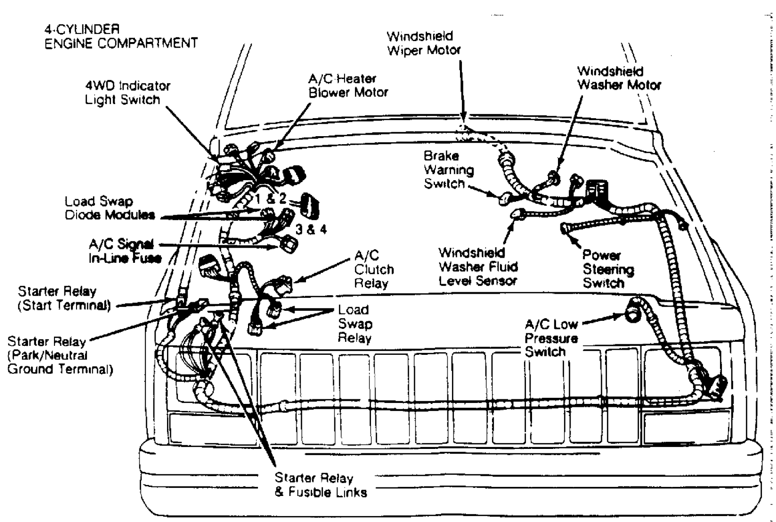


Idle Speed Actuator (ISA) Motor	On right side of throttle body.
Power Door Lock Motor	Behind trim panel in door.
Power Window Motor	Behind trim panel, in center of door.
Rear Washer Motor	In left front corner of engine compartment.
Rear Wiper Motor	Behind trim panel, in upper center of tailgate.



Windshield Washer Motor

On windshield washer reservoir.

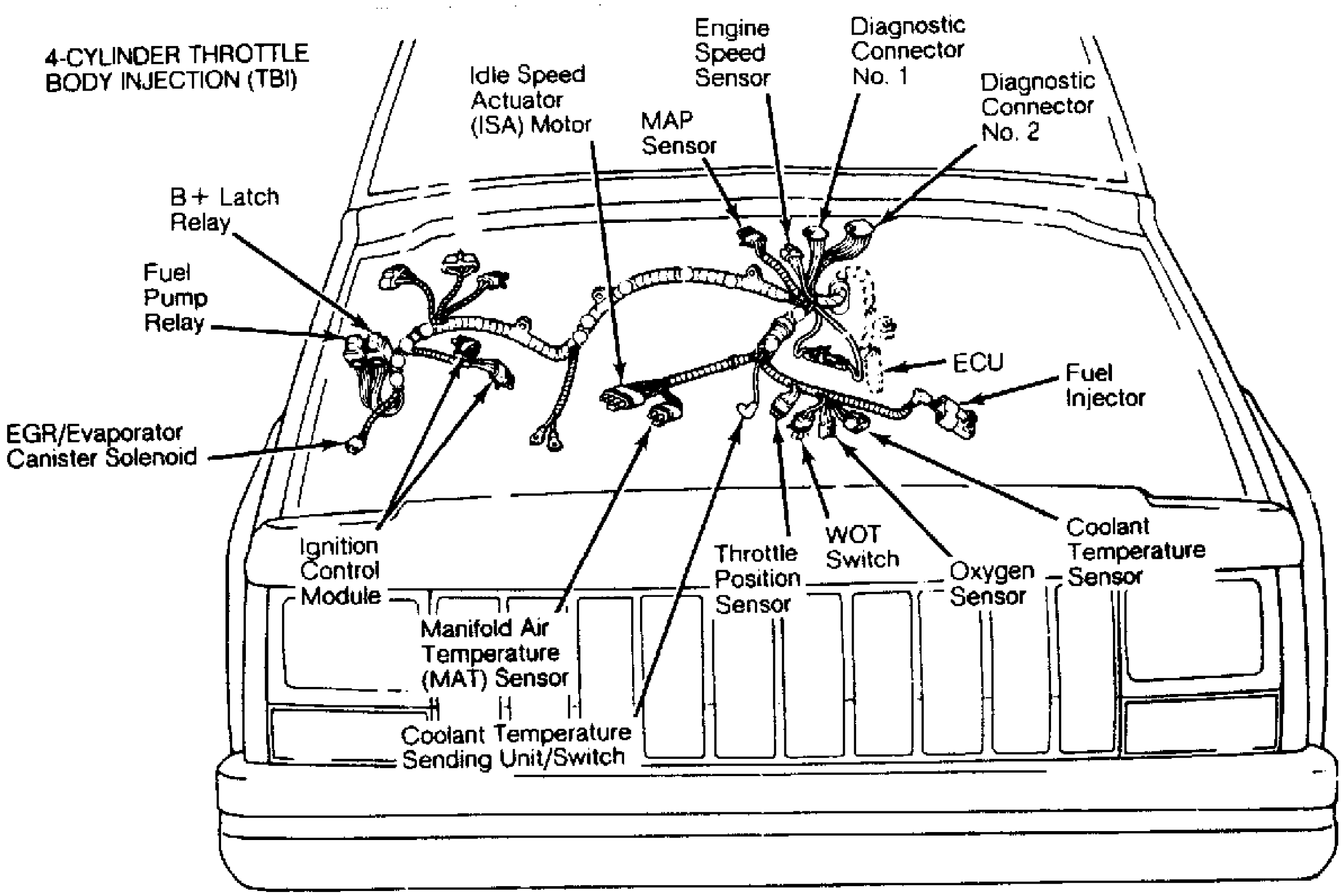

4-CYLINDER
ENGINE COMPARTMENT
Windshield
Wiper Motor
4WD Indicator
Light Switch
A/C Heater
Blower Motor
Windshield
Washer Motor
Brake
Warning
Switch
Load Swap
Diode Modules
1 & 2
3 & 4
A/C Signal
In-Line Fuse
A/C
Clutch
Relay
Windshield
Washer Fluid
Level Sensor
Power
Steering
Switch
Starter Relay
(Start Terminal)
Load
Swap
Relay
A/C Low
Pressure
Switch
Starter Relay
(Park/Neutral
Ground Terminal)
Starter Relay
& Fusible Links

Windshield Wiper Motor

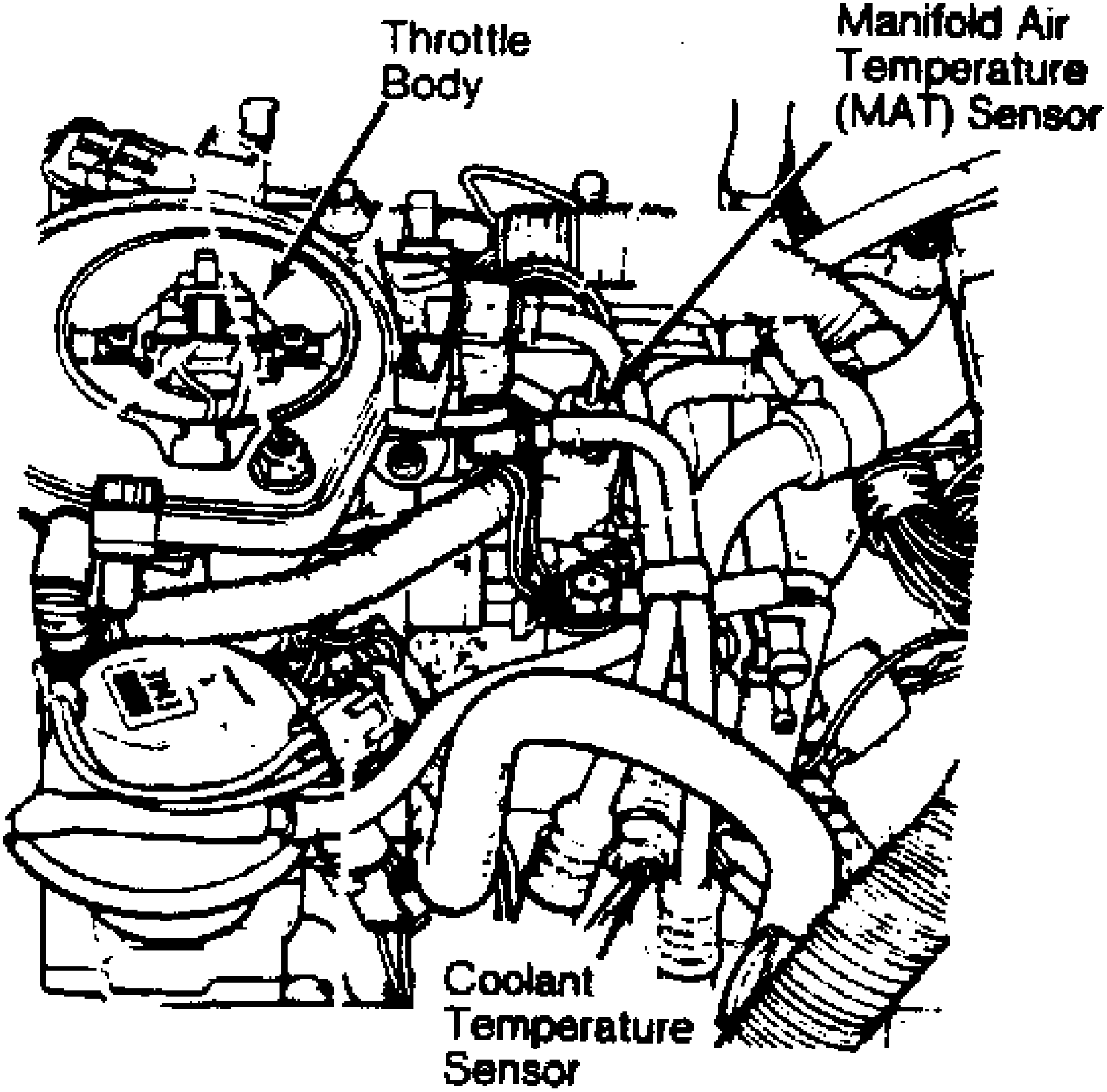
Under left side of cowl panel grille.

SENDING UNITS & SENSORS

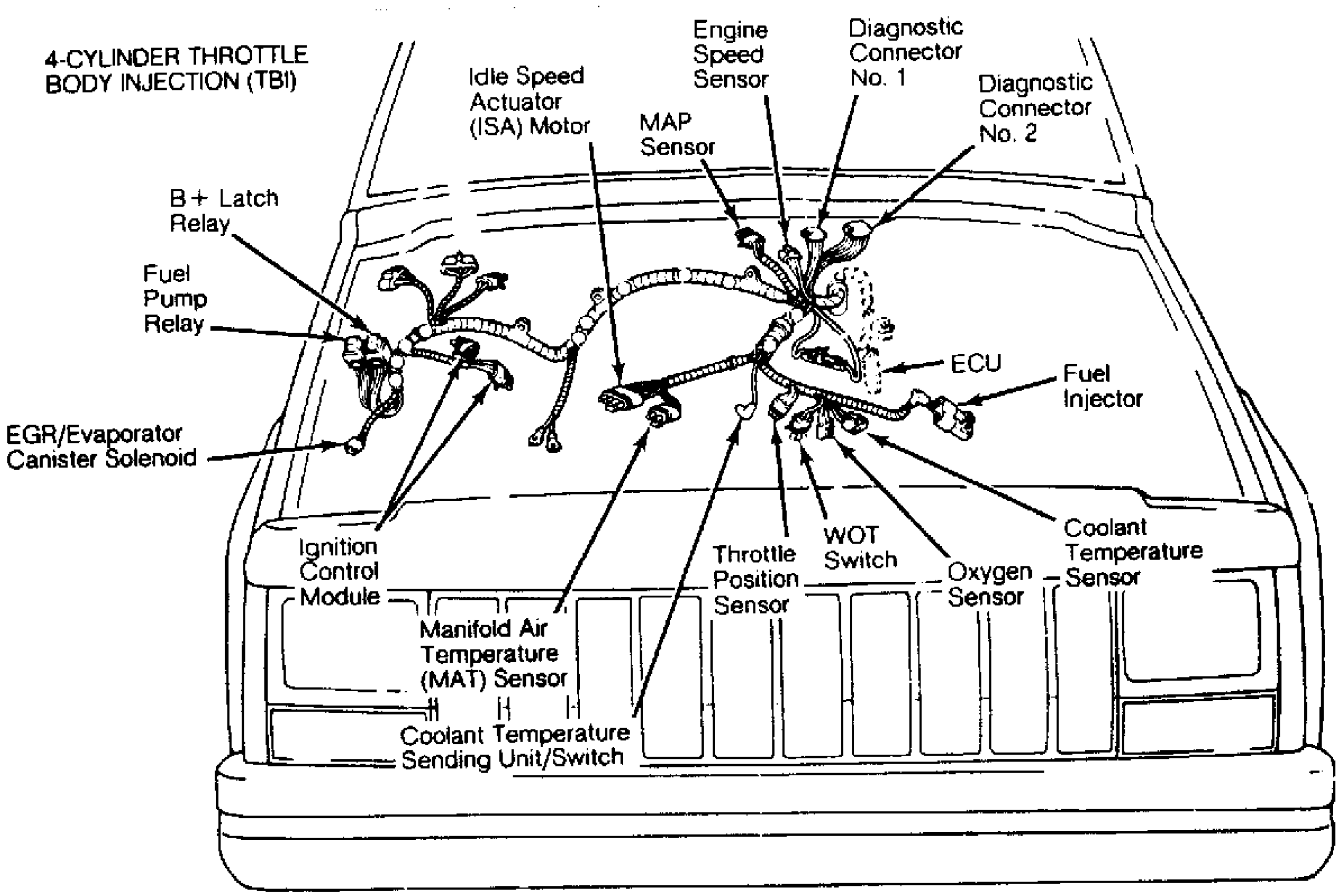
Component	Component Location
Automatic Load Leveling Sensor	On top of left rear axle.
Brake Pad Wear Sensors	In both inner front brake pads.
Coolant Temp. Sending Unit/Switch	



4-Cyl.	On top left rear of cylinder head.
6-Cyl.	On top front of cylinder head.
Coolant Temperature Sensor	

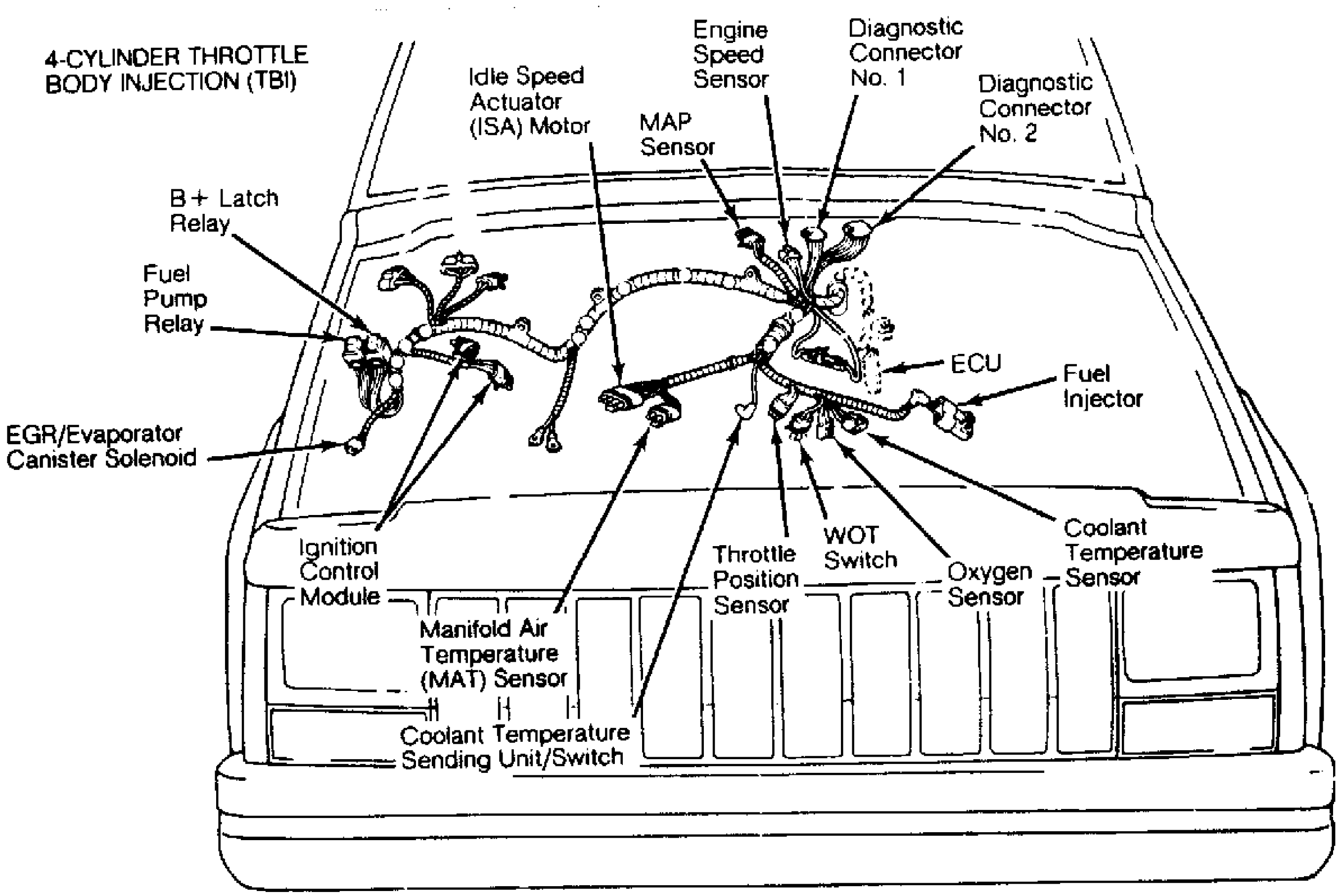


4-Cyl. (Graphic 1)	In left rear side of intake manifold.

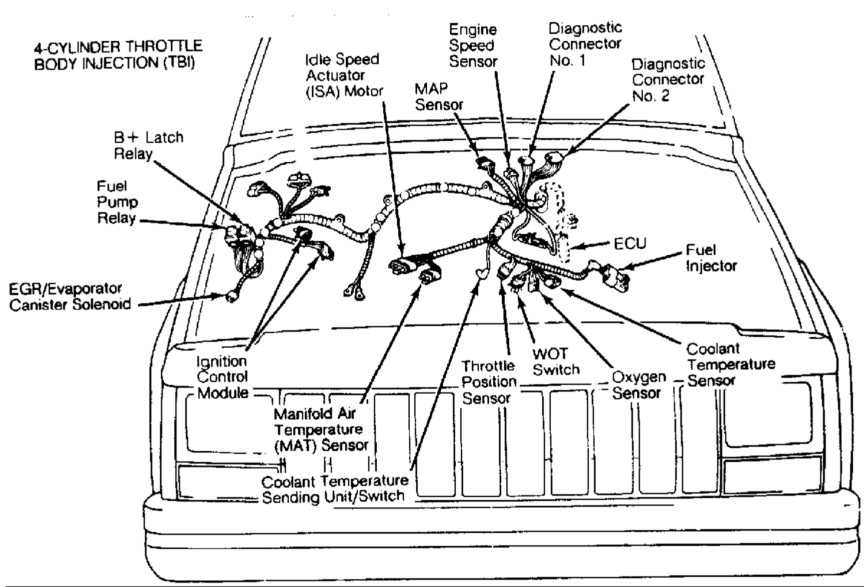


4-Cyl. (Graphic 2)	In left rear side of intake manifold.
6-Cyl.	Left side of engine block, under intake manifold

Engine Speed Sensor



Automatic Transmission	On left side of torque converter clutch.

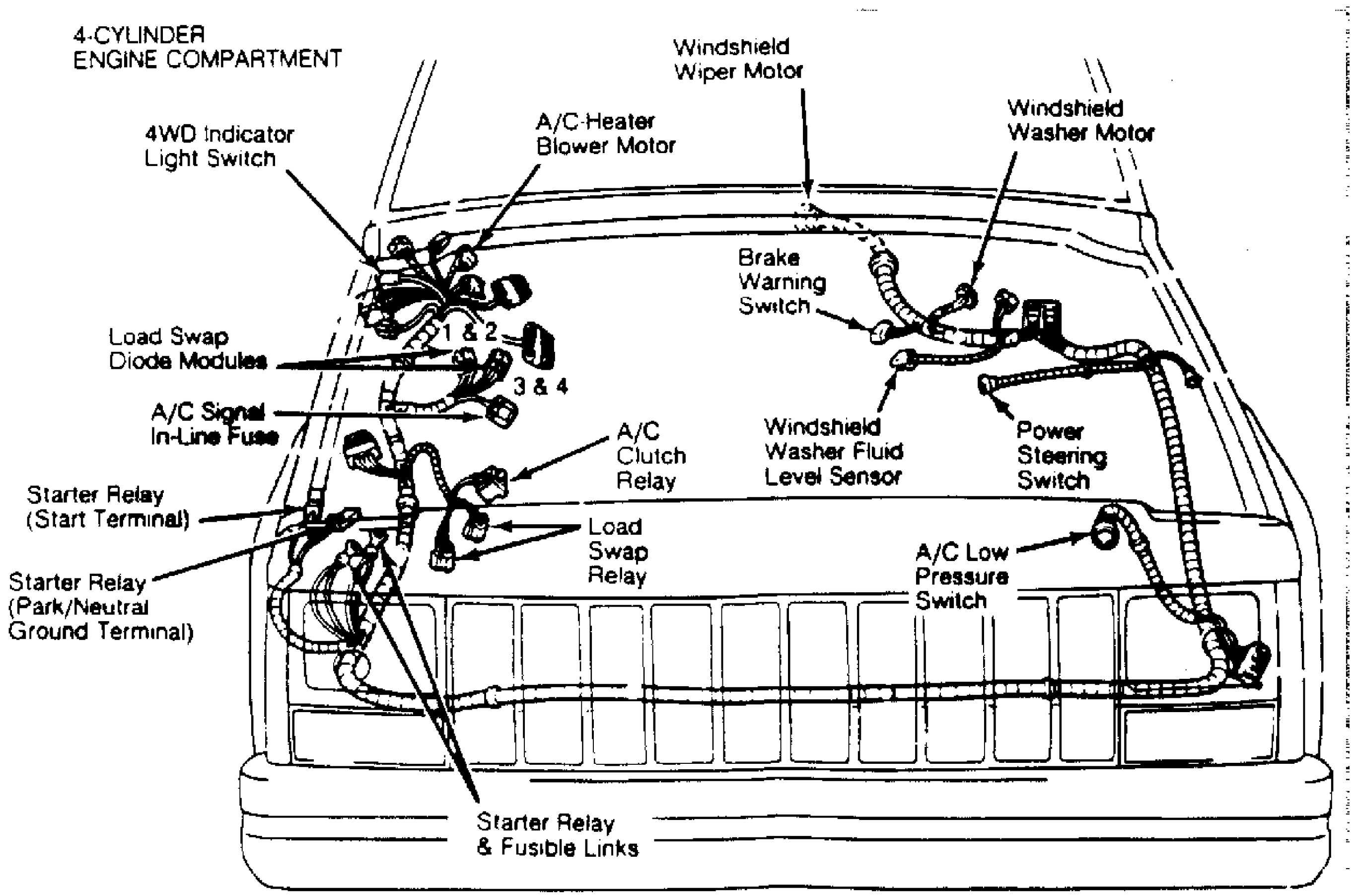


Manual Transmission	On left side of bellhousing.

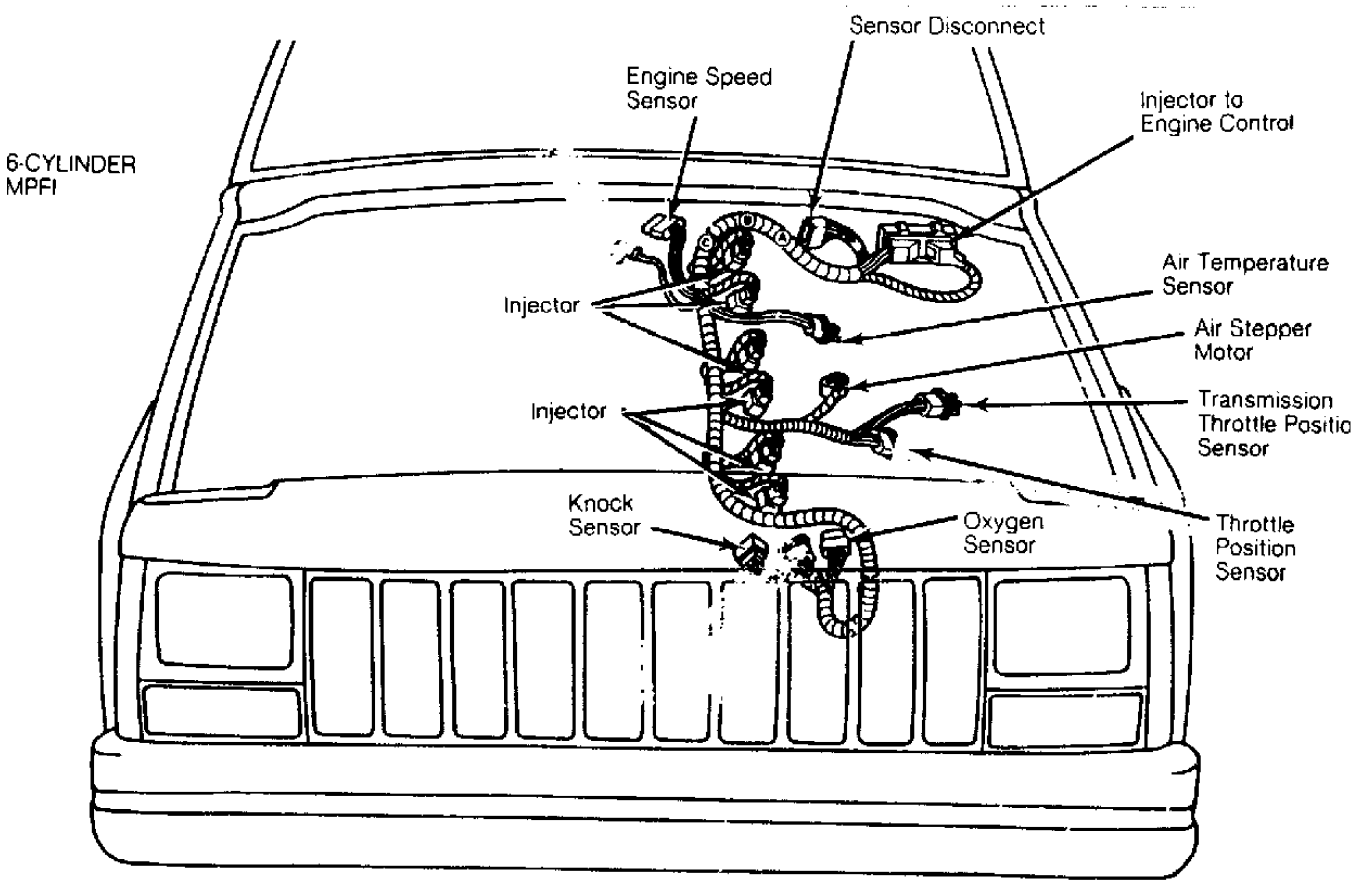
Fluid Level Sensors

Brake Fluid	In master cylinder.

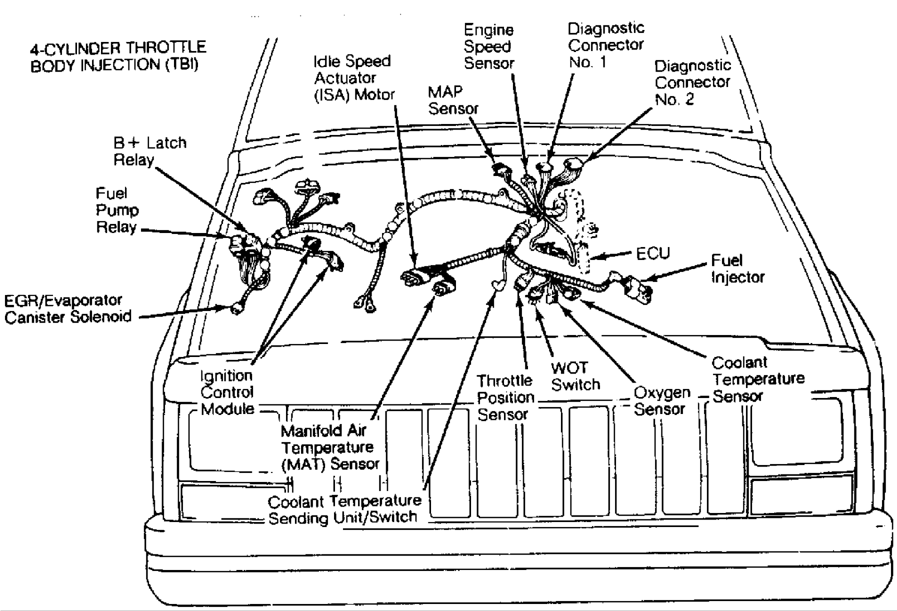
Engine Coolant	In coolant overflow bottle.
Engine Oil	In oil pan.
Front/Rear Axles	On front/rear of differential.
Power Steering	In power steering pump reservoir.
Transfer Case	In rear portion of transfer case.
Transmission	On fill plug (M/T) or dipstick (A/T).



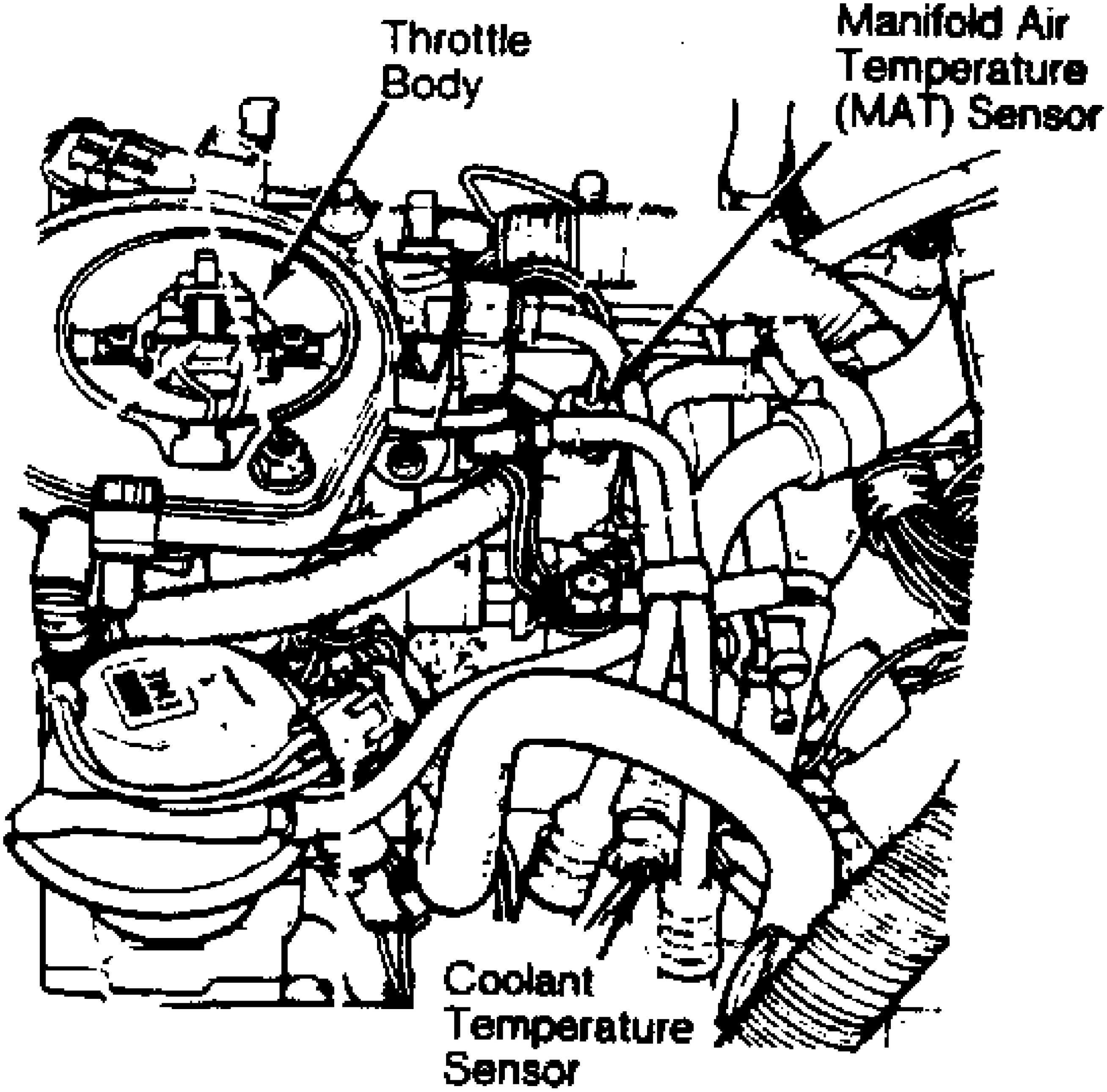
Windshield Washer	On bottom of windshield washer reservoir.
Fuel Gauge Sending Unit	In fuel tank.



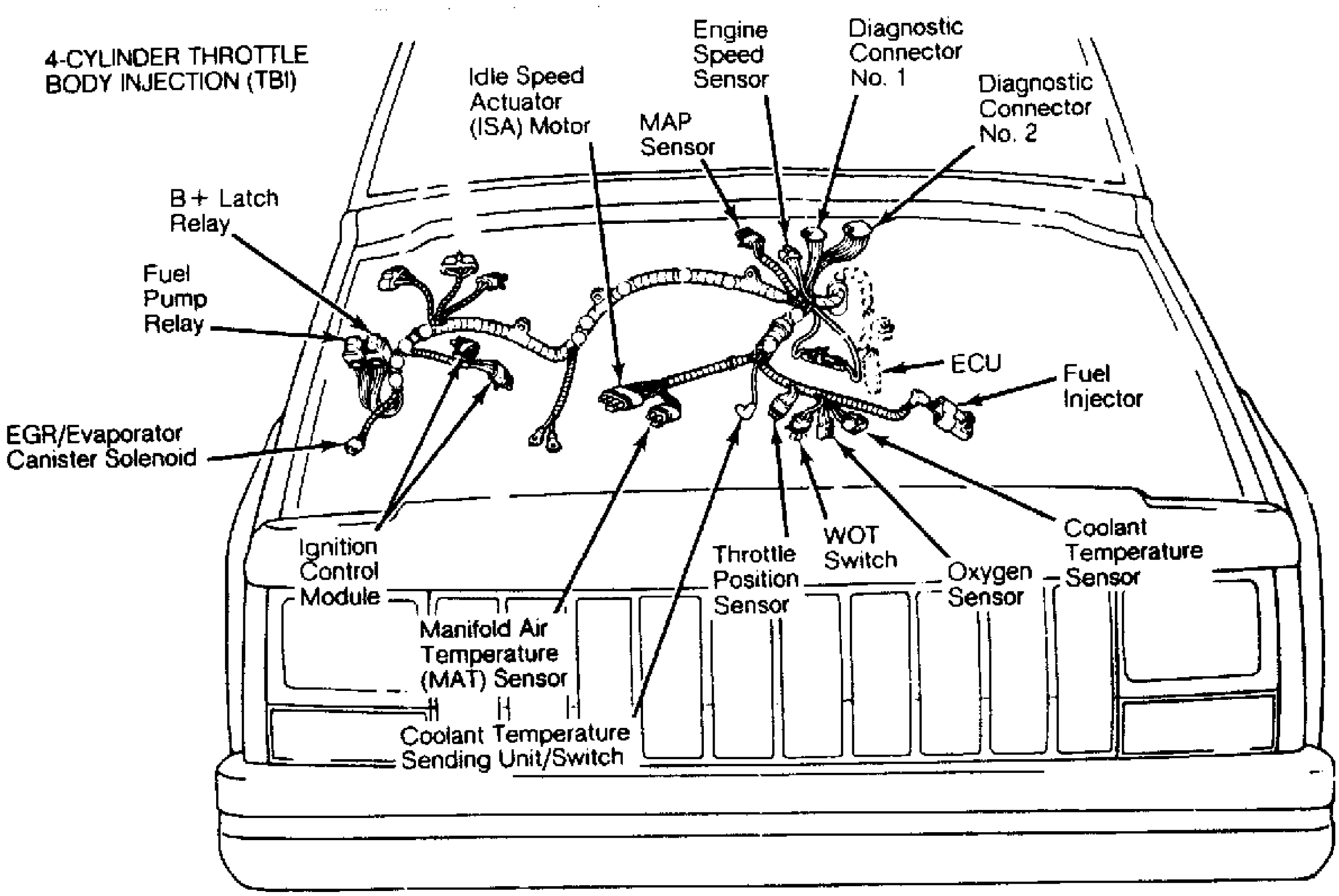
Knock Sensor — On lower front of engine.



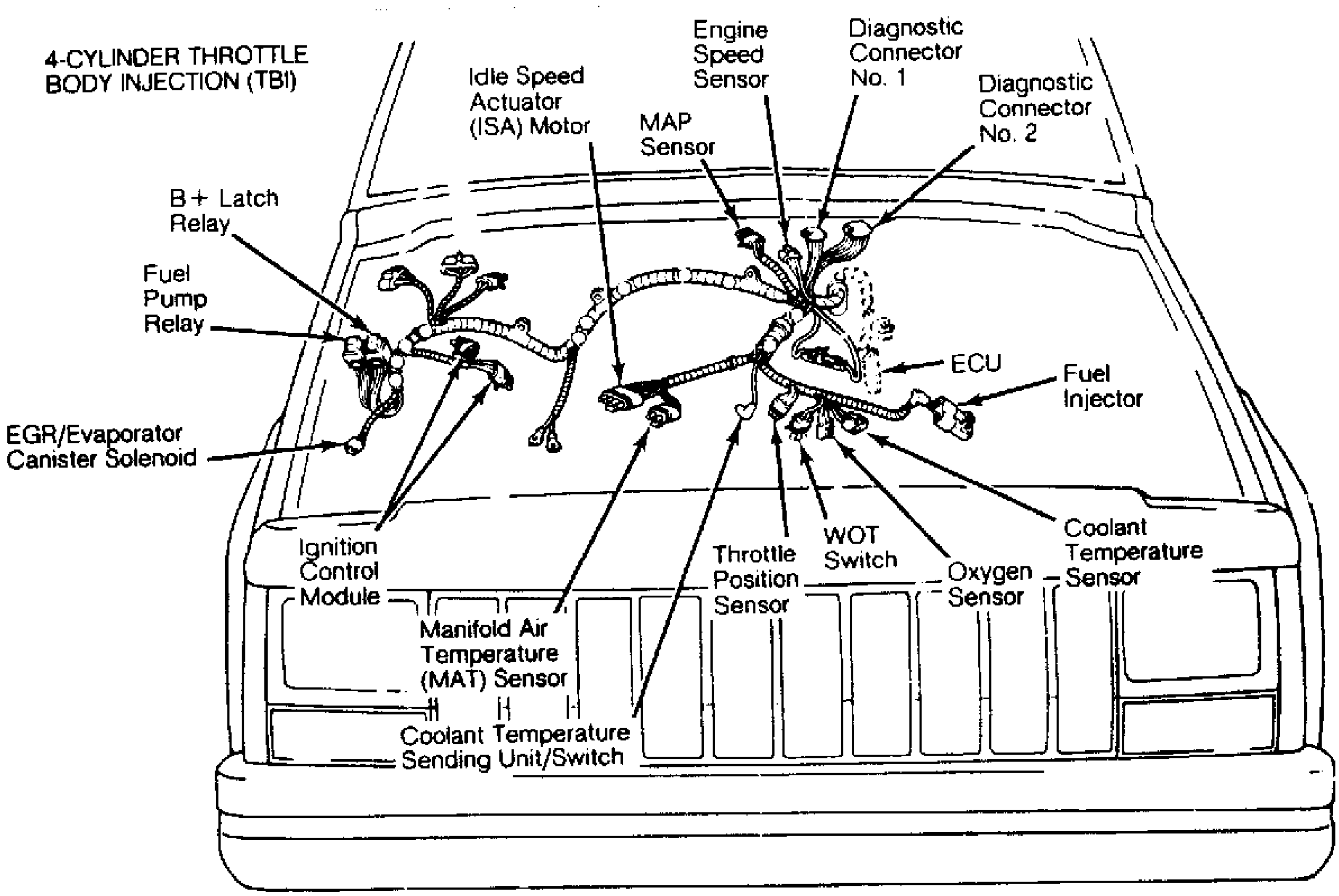
Manifold Absolute Pressure (MAP) Sensor — In engine compartment, on center of firewall.



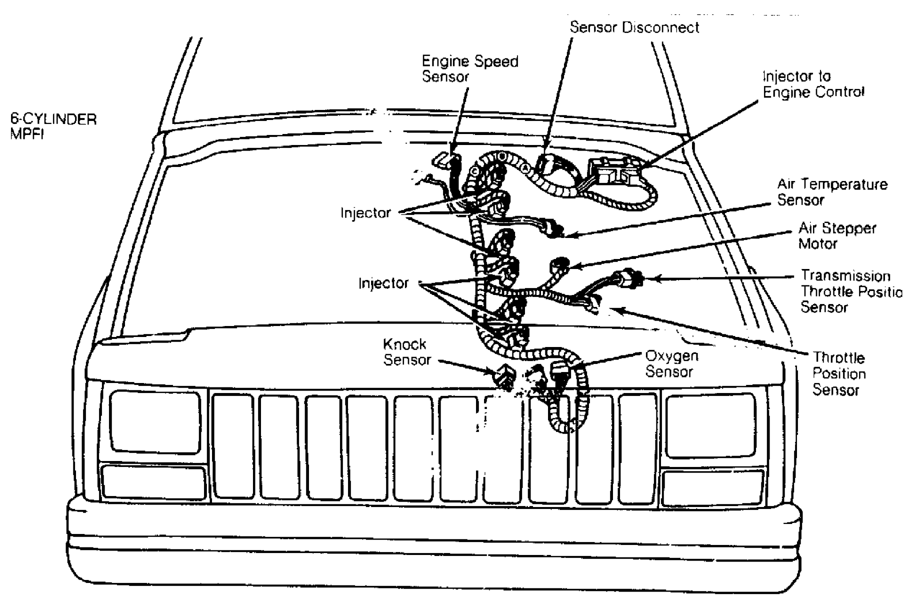
Manifold Air Temperature (MAT) Sensor (Graphic 1)	On upper rear of intake manifold.



Manifold Air Temperature (MAT) Sensor (Graphic 2)	On upper rear of intake manifold.
Oil Pressure Sending Unit/Switch	On right side of block, near distributor.



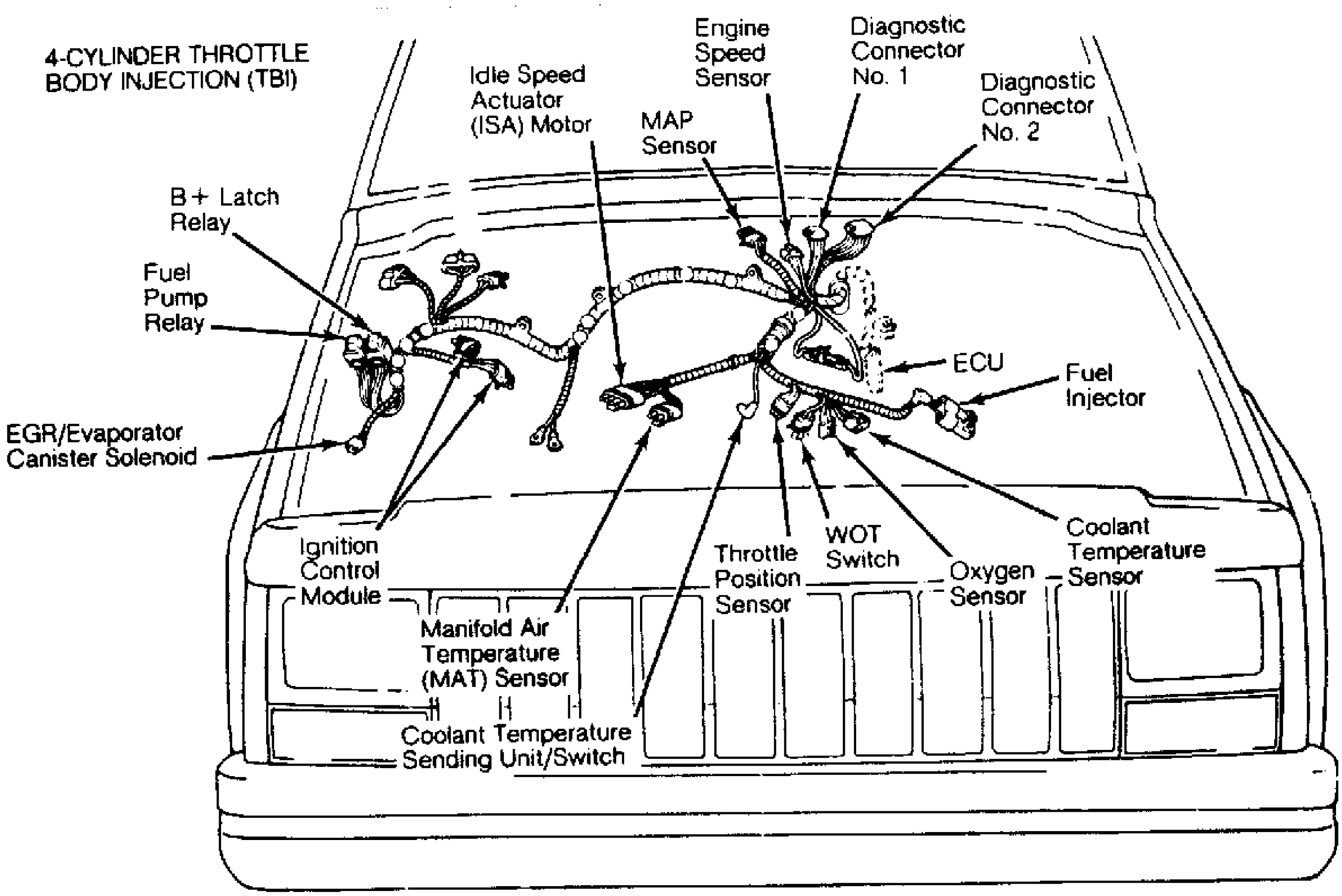
Oxygen Sensor (Graphic 1) In exhaust manifold, near exhaust pipe flange.



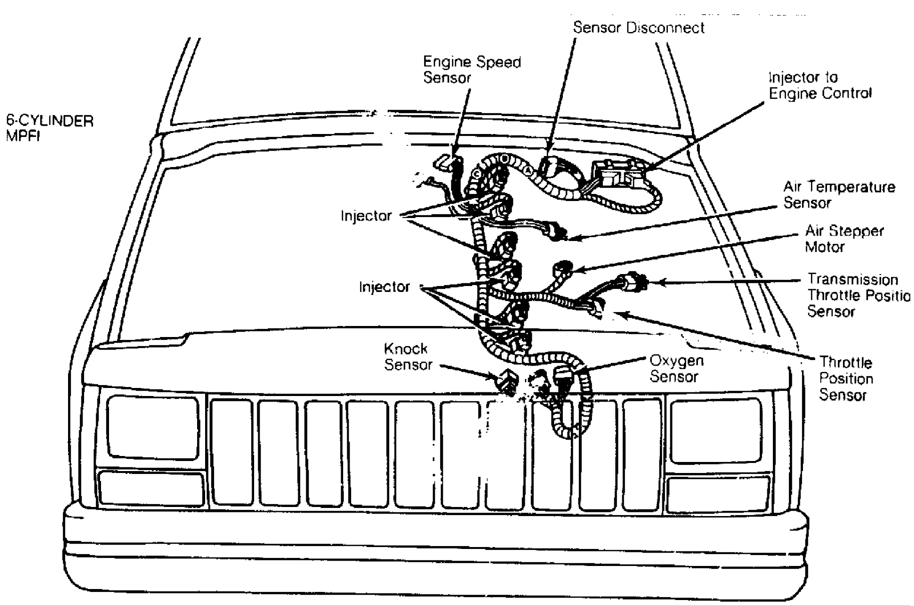
Oxygen Sensor (Graphic 2) In exhaust manifold, near exhaust pipe flange.

Road Speed Sensor Under instrument cluster, in

speedometer cable.



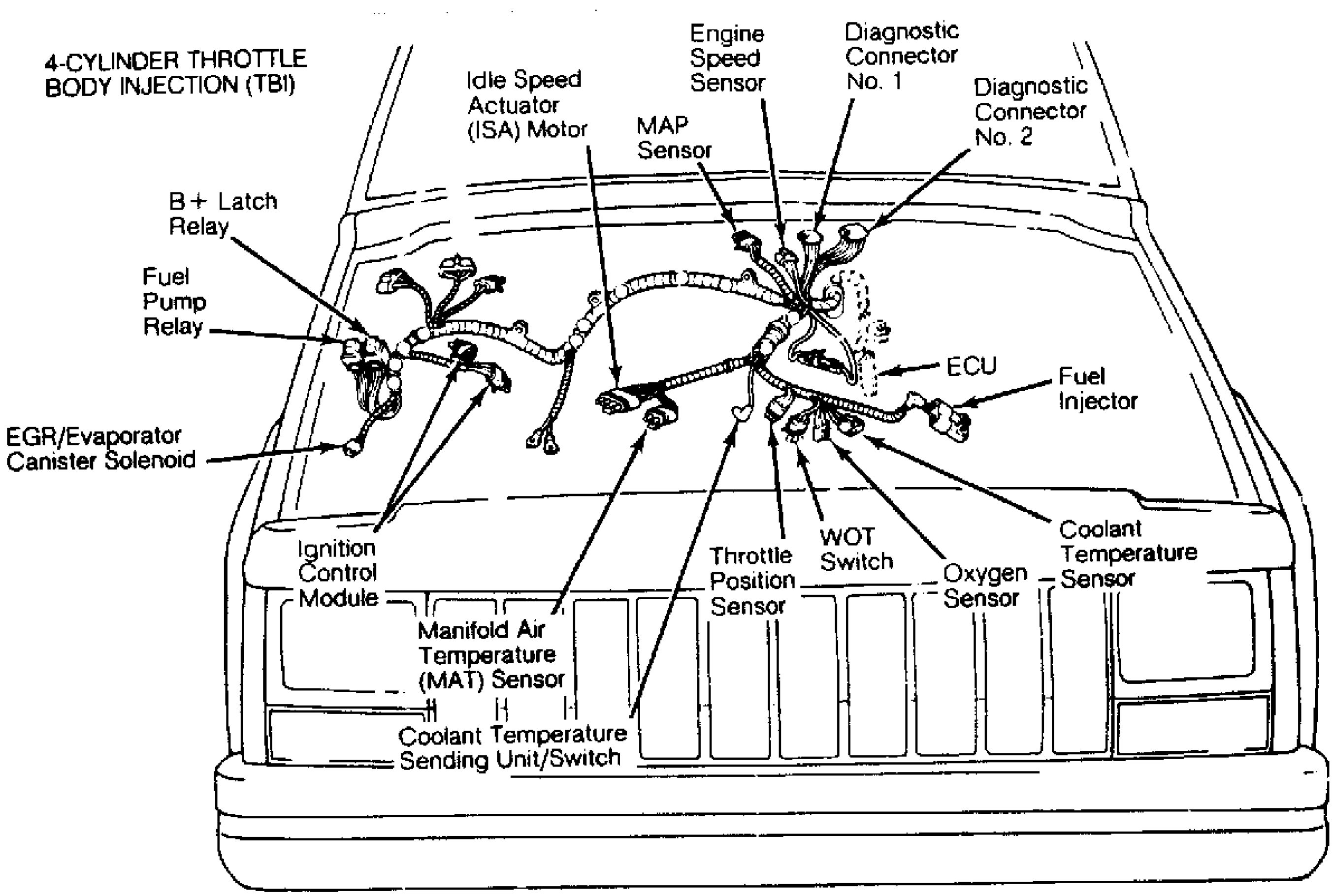
Throttle Position Sensor (TPS) (Graphic 1) On throttle body.



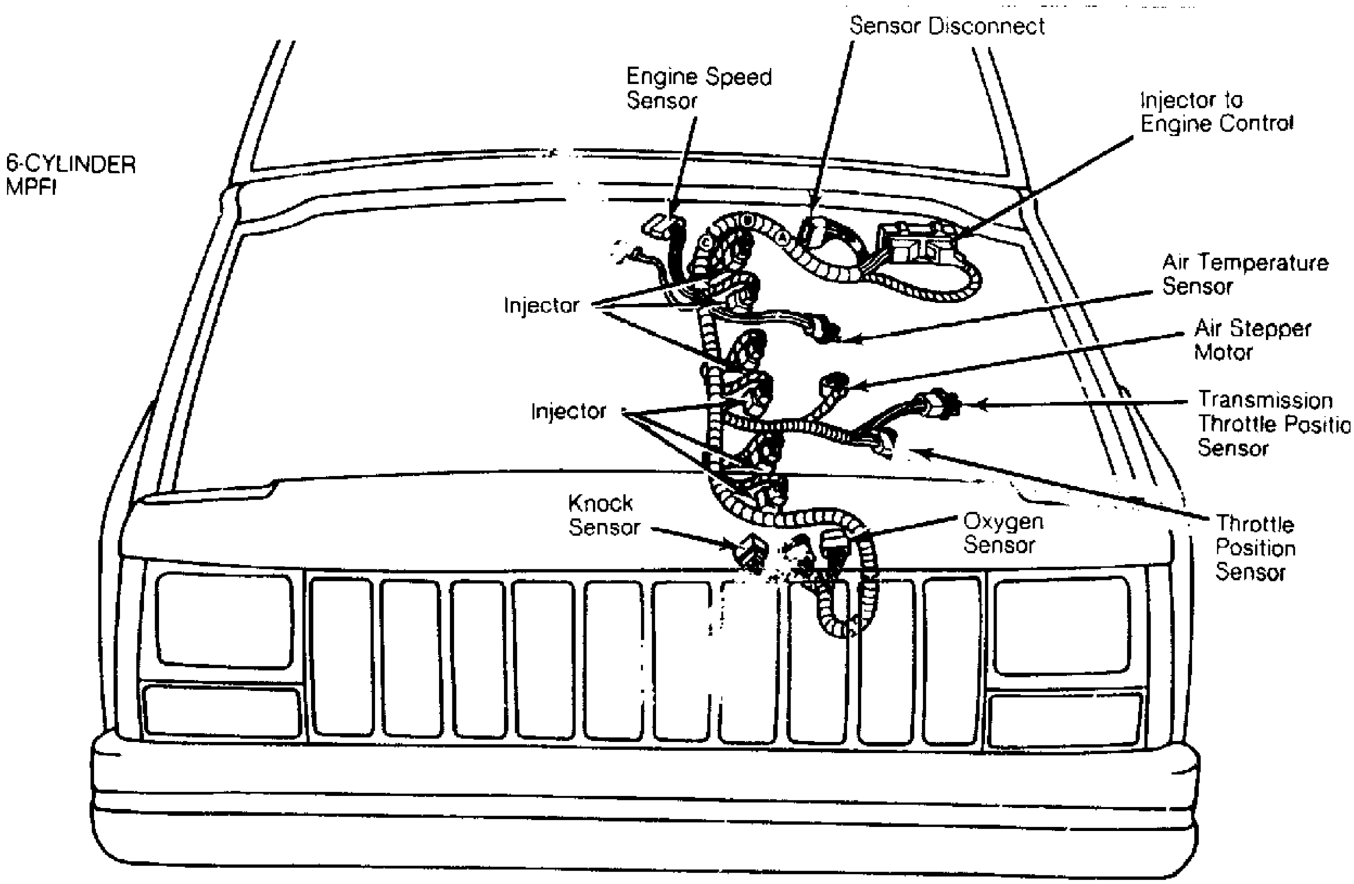
Throttle Position Sensor (TPS) (Graphic 2) On throttle body.

SOLENOIDS & SOLENOID VALVES

Component	Component Location
Air Diverter Solenoid	On right rear side of engine compartment.



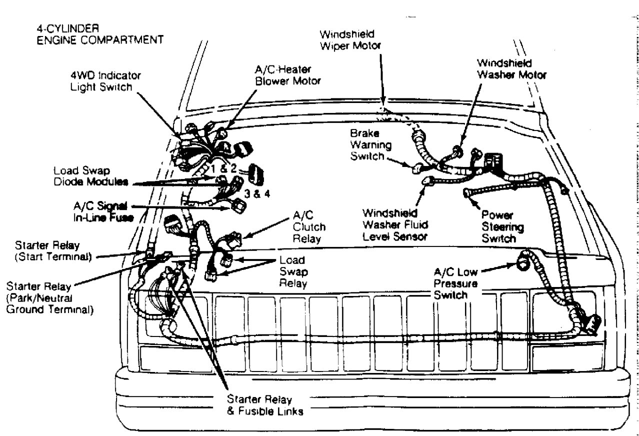
Component	Component Location
EGR/Evaporator Canister Solenoid	On middle of right front wheelwell.
Idle Step-Up Solenoid	On top fuel injection pump bracket.



Mixture Control Solenoid	On carburetor, near fuel line.
Shift Kicker Solenoid	On left front wheelwell.

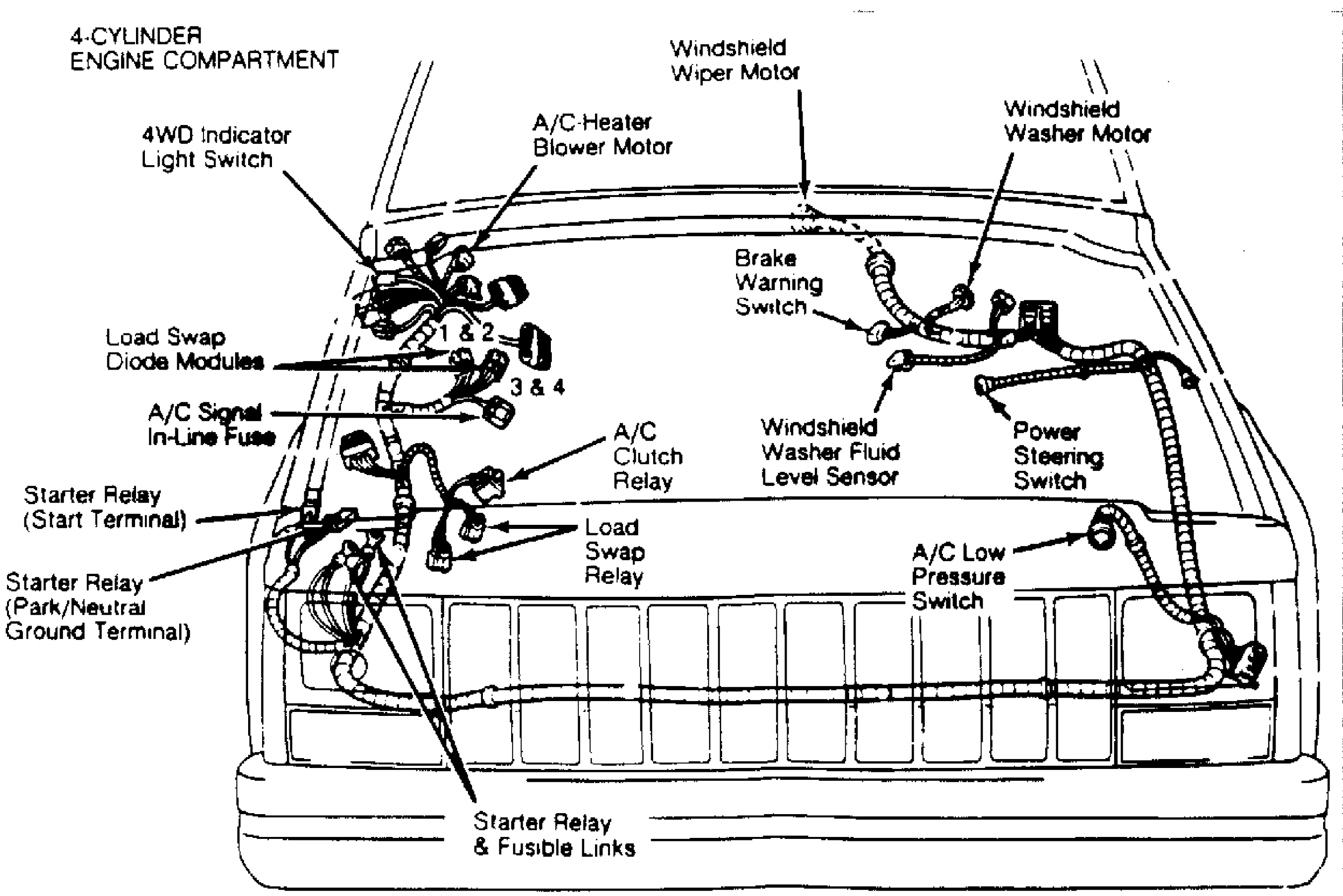
SWITCHES

Component	Component Location

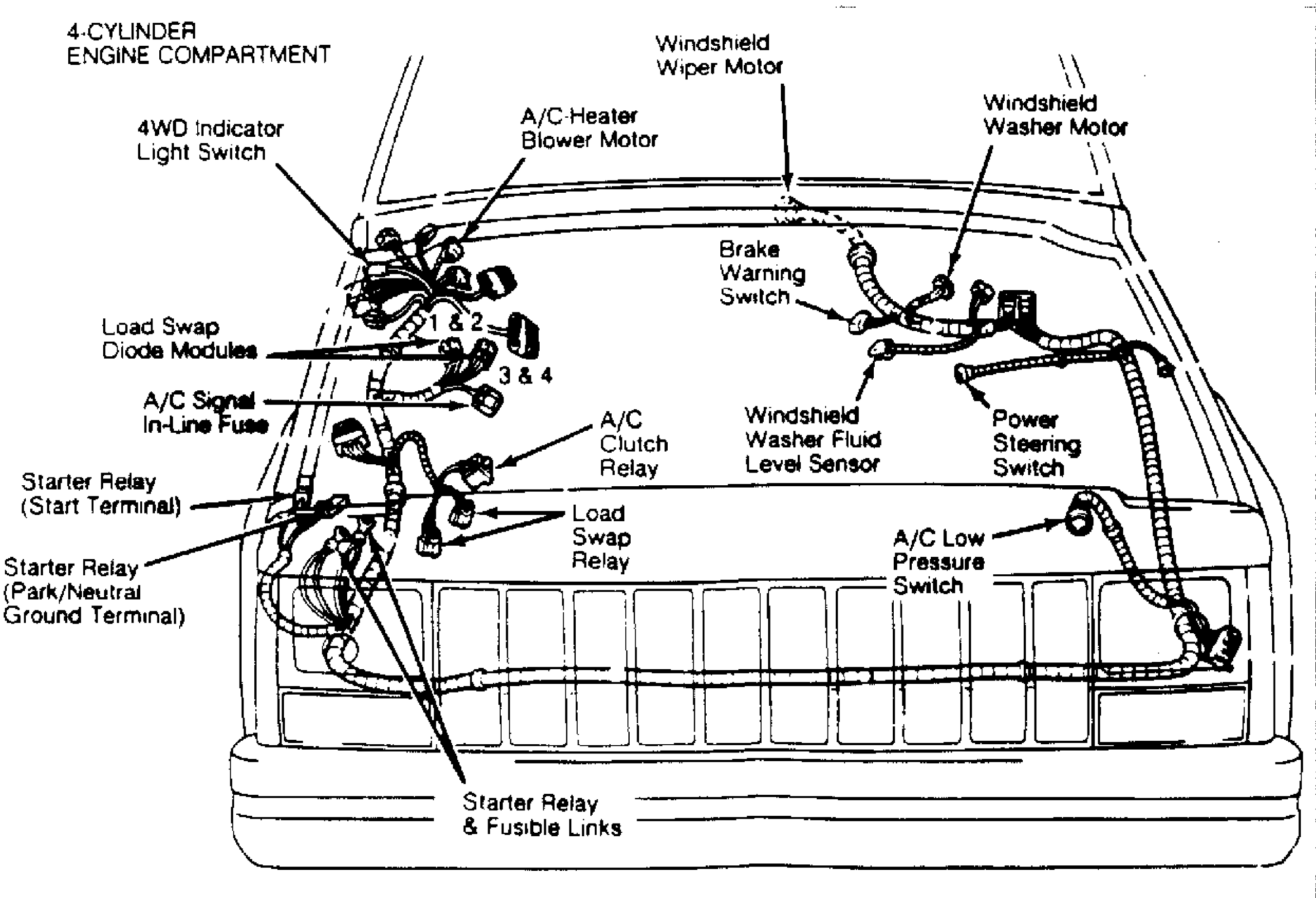


A/C Low Pressure Switch	On top left side of radiator.

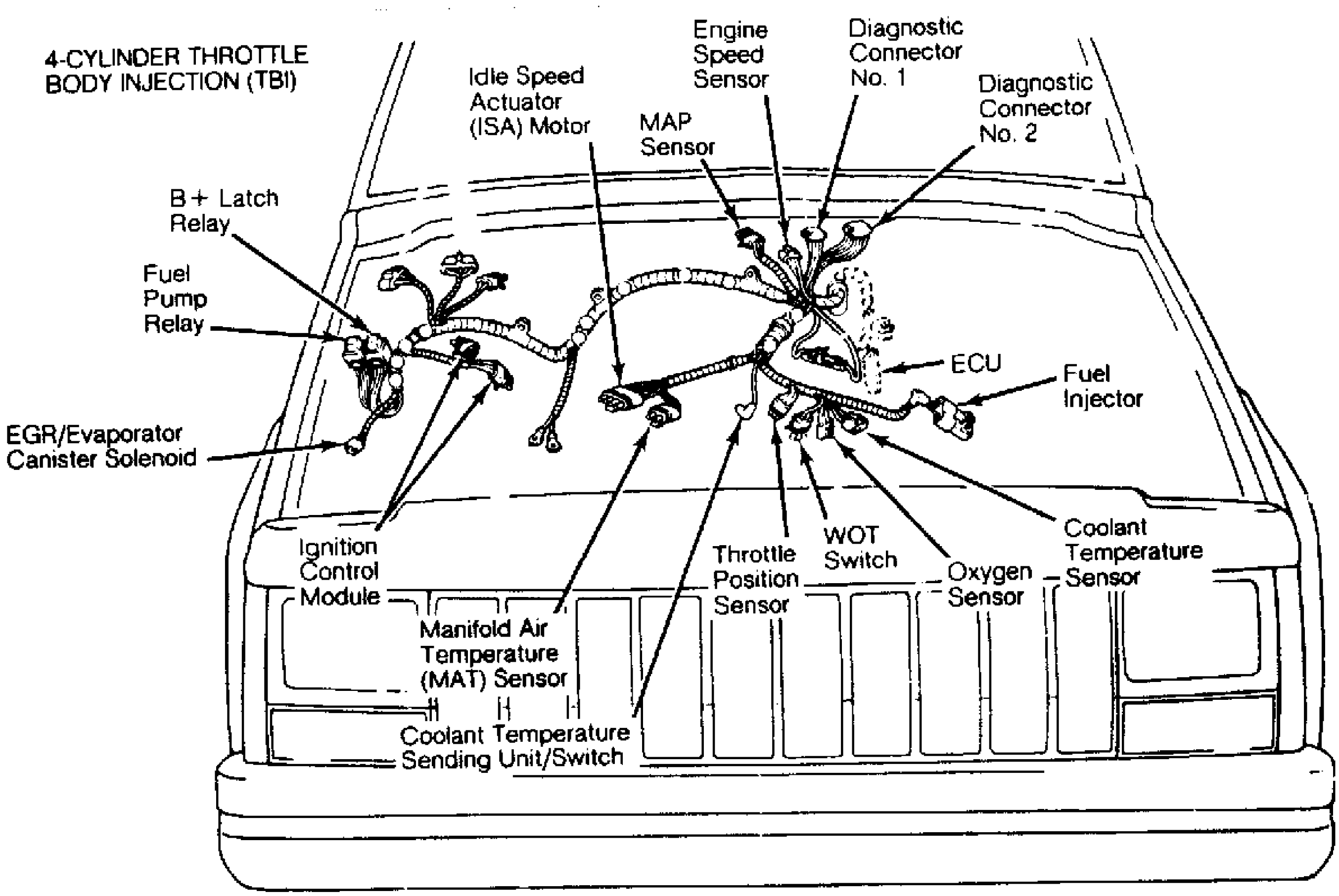
Automatic Load Leveling Sw.	On compressor bracket, in engine compartment.
Back-Up Light Sw. (Man. Trans.)	On left side of transmission case.
Back-Up/Neutral Sw. (Auto. Trans.)	On left side of transmission case.
Brake/Stop Light (Cruise) Switch	On brake pedal bracket.



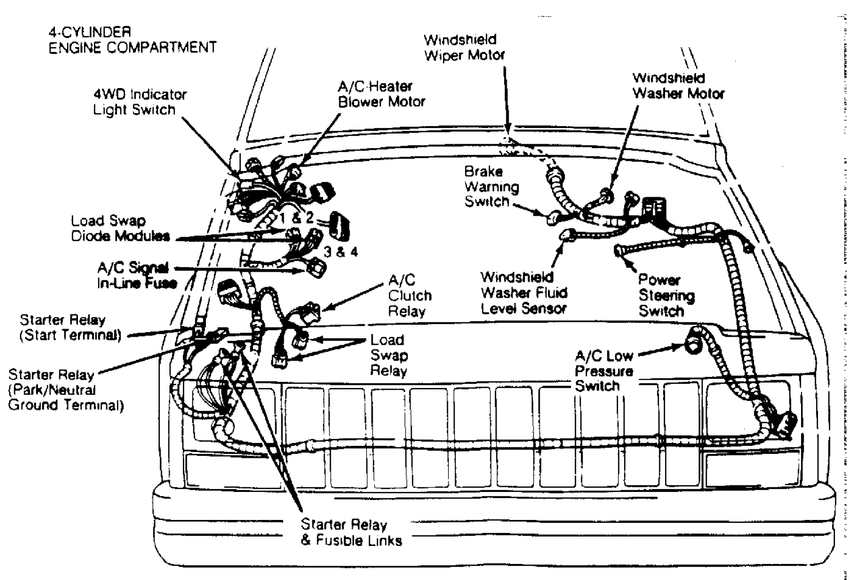
Brake Warning Switch	On brake pressure differential valve, below master cylinder.
Closed Throttle (Idle) Switch	An integral part of ISA motor.
Command Track Switch	On left side of transmission.
Parking Brake Switch	Under center console, at base of parking brake lever.



Power Steering Switch (4-Cyl.)	On left side of power steering pump.
Seat Belt Switch	In driver's seat belt buckle.
Select Trac Switch	On left side of transmission.



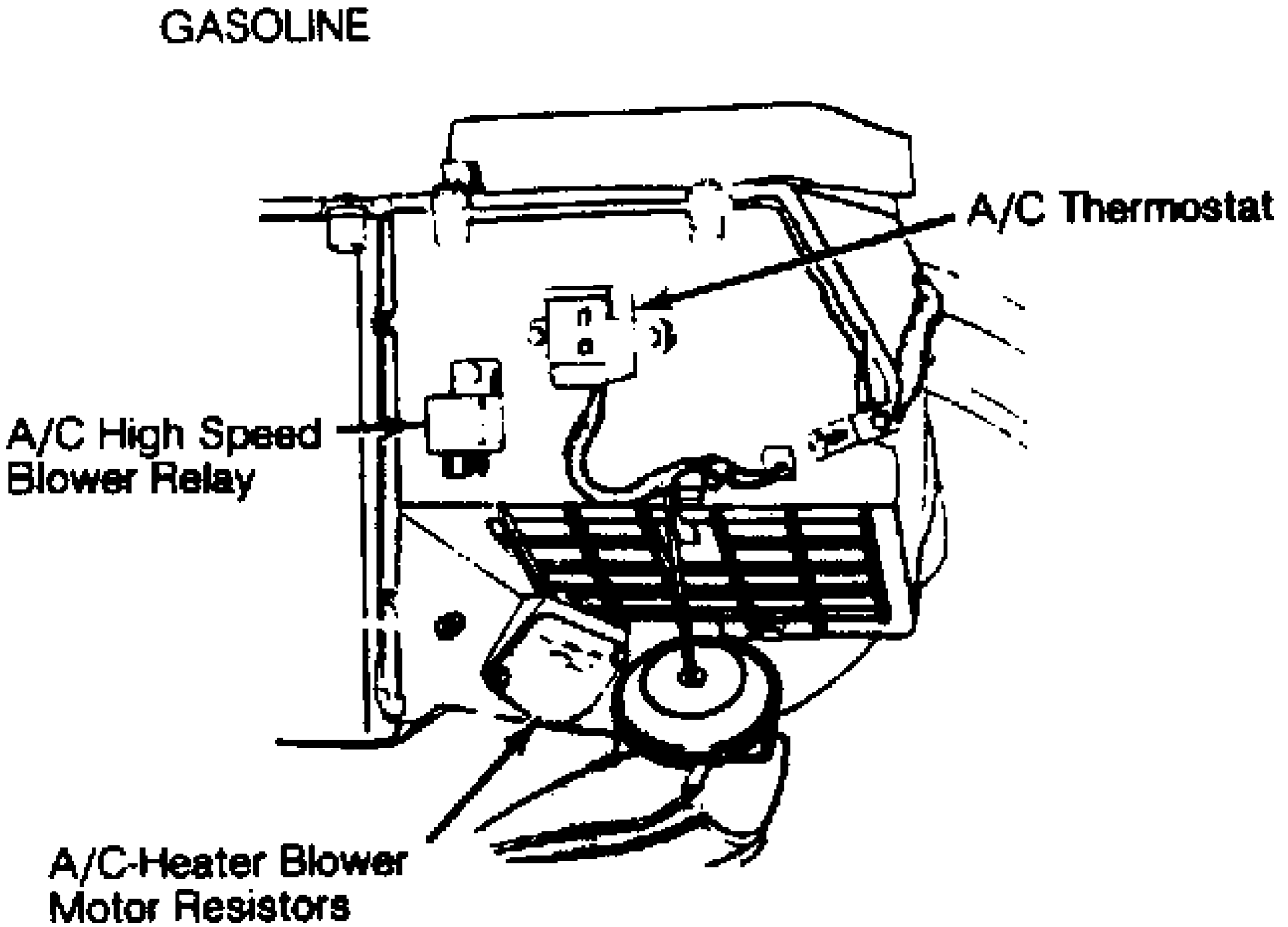
WOT Switch	On bracket, with ISA motor.



4WD Indicator Light Switch	In right rear corner of engine compartment.

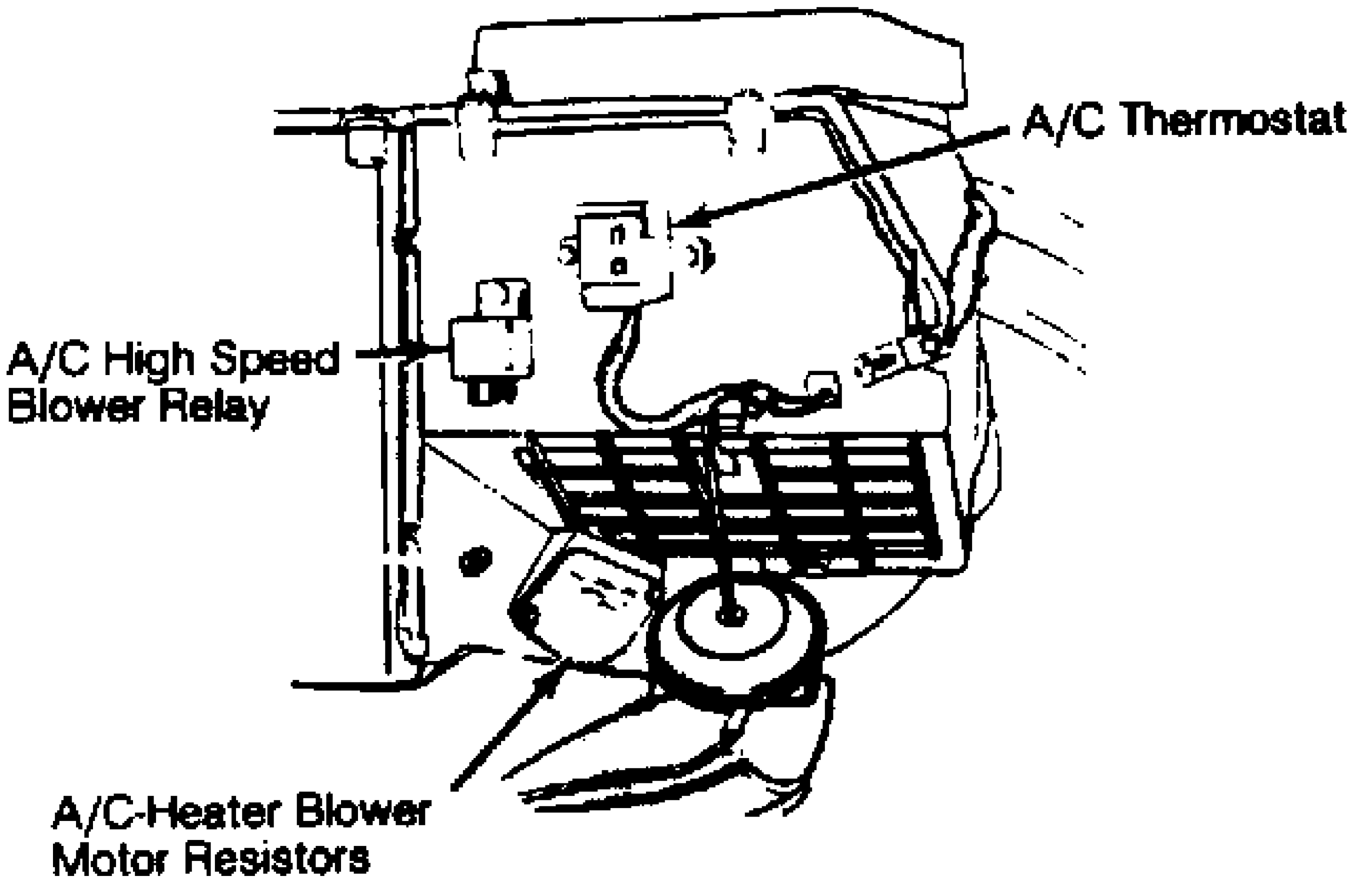
MISCELLANEOUS COMPONENTS

Component	Component Location
A/C Blocking Diode	Taped to engine wiring harness, above left wheelwell.
A/C Clutch Diode	On A/C compressor.

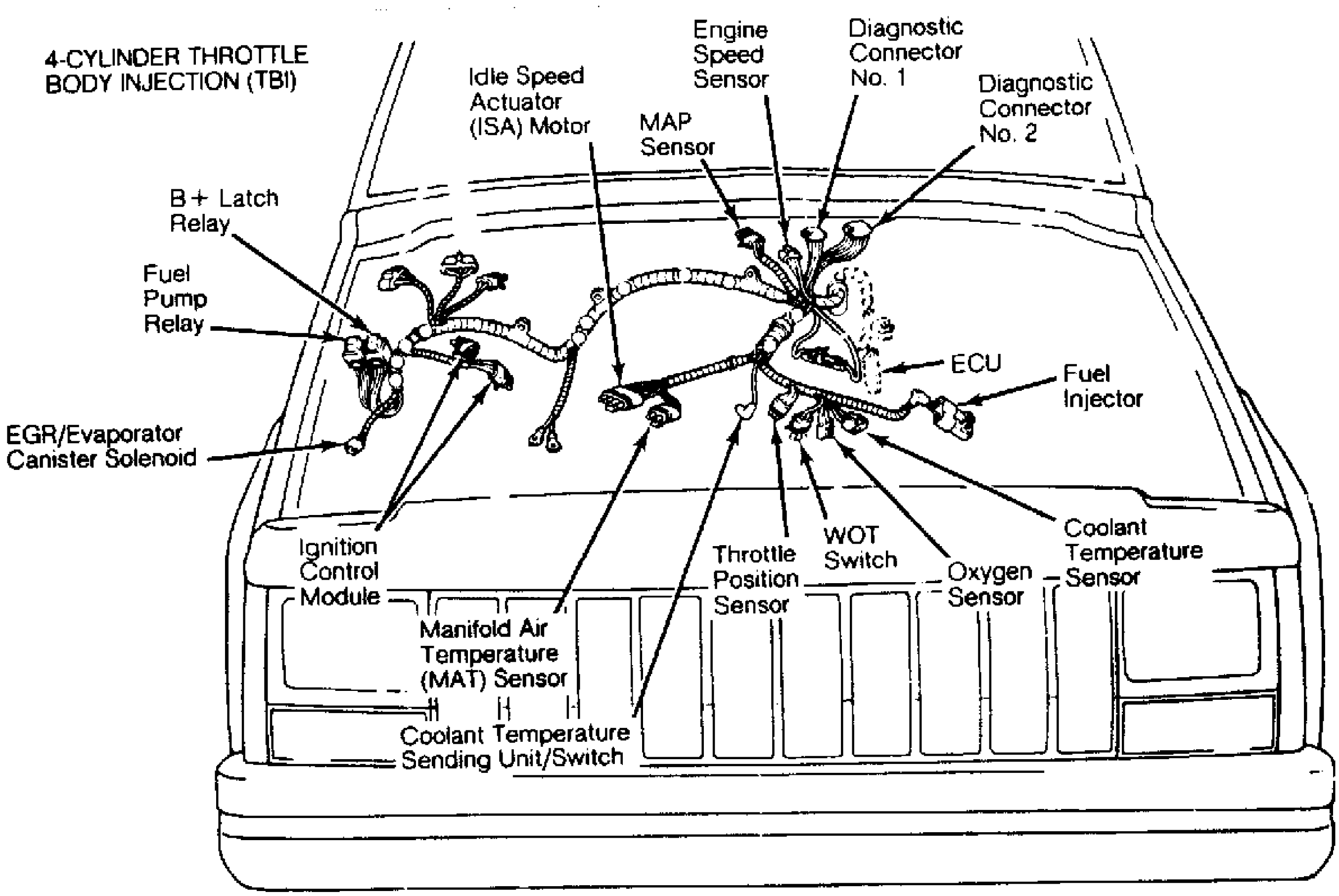


A/C-Heater Blower Motor Resistors	Under right side of dash, on evaporator housing.

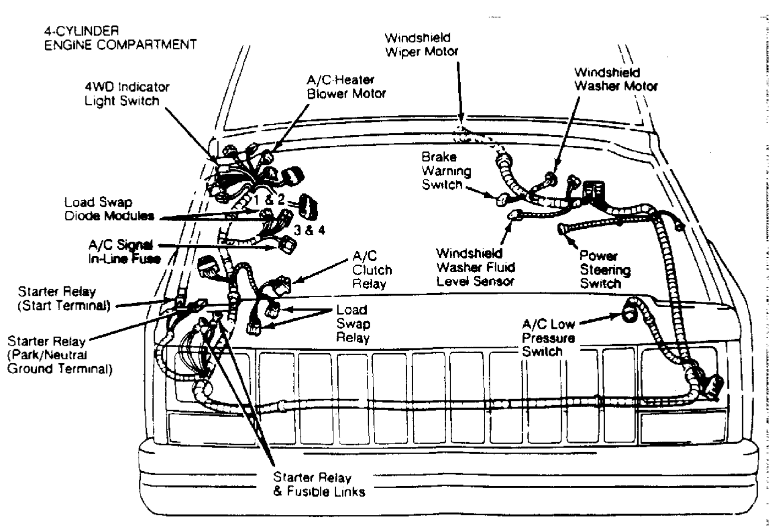
GASOLINE



A/C Thermostat	Under right side of dash, on evaporator housing.
Cruise Control Servo	In engine compartment, on right wheelwell.



Diagnostic Connectors	On center of firewall or on left side of engine compartment.



Load Swap Diode Modules	In engine wiring harness, near alternator.

* ELECTRICAL SYSTEM UNIFORM INSPECTION GUIDELINES *

1988 Jeep Cherokee

GENERAL INFORMATION
Electrical System Motorist Assurance Program
Standards For Automotive Repair

All Makes and Models

INTRODUCTION TO MOTORIST ASSURANCE PROGRAM (MAP)

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IGNITION SWITCHES
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KEYLESS ENTRY KEYPADS AND TRANSMITTERS
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MOTORS
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ODOMETERS, SPEEDOMETERS AND TACHOMETERS (CABLE-DRIVEN)
PULLEYS
RECEIVERS, AMPLIFIERS, EQUALIZERS AND SUB-WOOFER VOLUME CONTROLS
RELAY BOXES
RELAYS
SEALED BEAMS
SEAT HEATERS
SECURITY ALARM SENSORS
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TACHOMETERS
TAPE PLAYERS AND CD PLAYERS
TENSIONERS
TIMERS
TIRE PRESSURE SENSORS
TRANSCEIVERS
TRANSDUCERS
VACUUM ACCUMULATORS (RESERVOIRS)
VACUUM RESERVOIRS
VOLTAGE REGULATORS
WASHER FLUID LEVEL SENDERS
WASHER PUMPS
WIPER ARMS AND BLADES
WIPER BLADES
WIPER HOSES AND NOZZLES
WIPER LINKAGES
WIPER NOZZLES
WIPER PUMP RESERVOIRS
WIRING HARNESSES AND CONNECTORS

INTRODUCTION TO MOTORIST ASSURANCE PROGRAM (MAP)

OVERVIEW OF MOTORIST ASSURANCE PROGRAM

The Motorist Assurance Program is the consumer outreach effort of the Automotive Maintenance and Repair Association, Inc. (AMRA). Participation in the Motorist Assurance Program is drawn from retailers, suppliers, independent repair facilities, vehicle manufacturers and industry associations.

Our organization’s mission is to strengthen the relationship between the consumer and the auto repair industry. We produce materials that give motorists the information and encouragement to take greater responsibility for their vehicles-through proper,

manufacturer-recommended, maintenance. We encourage participating service and repair shops (including franchisees and dealers) to adopt (1) a Pledge of Assurance to their Customers and (2) the Motorist Assurance Program Standards of Service. All participating service providers have agreed to subscribe to this Pledge and to adhere to the promulgated Standards of Service demonstrating to their customers that they are serious about customer satisfaction.

These Standards of Service require that an inspection of the vehicle's (problem) system be made and the results communicated to the customer according to industry standards. Given that the industry did not have such standards, the Motorist Assurance Program successfully promulgated industry inspection communication standards in 1994-95 for the following systems: Exhaust, Brakes, ABS, Steering and Suspension, Engine Maintenance and Performance, HVAC, and Electrical Systems. Further, revisions to all of these inspection communication standards are continually re-published.

In addition to these, standards for Drive Train and Transmissions have recently been promulgated. Participating shops utilize these Uniform Inspection & Communication Standards as part of the inspection process and for communicating their findings to their customers.

The Motorist Assurance Program continues to work cooperatively and proactively with government agencies and consumer groups toward solutions that both benefit the customer and are mutually acceptable to both regulators and industry. We maintain the belief that industry must retain control over how we conduct our business, and we must be viewed as part of the solution and not part of the problem. Meetings with state and other government officials (and their representatives), concerned with auto repair and/or consumer protection, are conducted. Feedback from these sessions is brought back to the association, and the program adjusted as needed.

To assure auto repair customers recourse if they were not satisfied with a repair transaction, the Motorist Assurance Program offers mediation and arbitration through MAP/BBB-CARE and other non-profit organizations. MAP conducted pilot programs in twelve states before announcing the program nationally in October, 1998. During the pilots, participating repair shops demonstrated their adherence to the Pledge and Standards and agreed to follow the UICS in communicating the results of their inspection to their customers. To put some "teeth" in the program, an accreditation requirement for shops was initiated. The requirements are stringent, and a self-policing method has been incorporated which includes the "mystery shopping" of outlets.

We welcome you to join us as we continue our outreach... with your support, both the automotive repair industry and your customers will reap the benefits. Please visit MAP at our Internet site www. motorist.org or contact us at:

1444 I Street, NW Suite 700
Washington, DC 20005
Phone (202) 712-9042 Fax (202) 216-9646
January 1999

MAP UNIFORM INSPECTION GENERAL GUIDELINES

OVERVIEW OF SERVICE REQUIREMENTS & SUGGESTIONS

It is MAP policy that all exhaust, brake, steering, suspension, wheel alignment, drive-line, engine performance and maintenance, and heating, ventilation and air conditioning, and electrical services be offered and performed under the standards and procedures specified in these sections.

Before any service is performed on a vehicle, an inspection of the appropriate system must be performed. The results of this inspection must be explained to the customer and documented on an inspection form. The condition of the vehicle and its components will indicate what services/part replacements may be "Required" or "Suggested". In addition, suggestions may be made to satisfy the requests expressed by the customer.

When a component is suggested or required to be repaired or replaced, the decision to repair or replace must be made in the customer's best interest, and at his or her choice given the options available.

This section lists the various parts and conditions that indicate a required or suggested service or part replacement. Although this list is extensive, it is not fully inclusive. In addition to this list, a technician may make a suggestion. However, any suggestions must be based on substantial and informed experience, or the vehicle manufacturer's recommended service interval and must be documented.

Some conditions indicate that service or part replacement is required because the part in question is no longer providing the function for which it is intended, does not meet a vehicle manufacturer's design specification or is missing.

Example:
An exhaust pipe has corroded severely and has a hole in it through which exhaust gases are leaking. Replacement of the exhaust pipe in this case is required due to functional failure.

Example:
A brake rotor has been worn to the point where it measures less than the vehicle manufacturer's discard specifications. Replacement of the rotor is required because it does not meet design specifications.

Some conditions indicate that a service or part replacement is suggested because the part is close to the end of its useful life or addresses a customer's need, convenience or request. If a customer's vehicle has one of these conditions, the procedure may be only to suggest service.

Example:
An exhaust pipe is rusted, corroded or weak, but no leaks are present. In this case, the exhaust pipe has not failed. However, there is evidence that the pipe may need replacement in the near future. Replacement of the pipe may be suggested for the customer's convenience in avoiding a future problem.

Example:
The customer desires improved ride and/or handling, but the vehicle's shocks or struts have not failed. In this case, replacement may be suggested to satisfy the customer's wishes. In this case, replacement of the shocks or struts may not be sold as a requirement.

A customer, of course, has the choice of whether or not a shop will service his or her vehicle. He or she may decide not to follow some of your suggestions. When a repair is required, a MAP shop must refuse partial service on that system if, in the judgment of the service provider, proceeding with the work could create or continue an unsafe condition. When a procedure states that required or suggested repair or replacement is recommended, the customer must be informed of the generally acceptable repair/replacement options whether or not performed by the shop.

When presenting suggested repairs to the customer, you must present the facts, allowing the customer to draw their own conclusions and make an informed decision about how to proceed.

The following reasons may be used for required and suggested services. These codes are shown in the "Code" column of the MAP Uniform Inspection & Communications Standards that follow:

Reasons to Require Repair or Replacement

A - Part no longer performs intended purpose

B - Part does not meet a design specification (regardless of performance)

C - Part is missing

NOTE: When a repair is required, the shop must refuse partial service to the system in question, if the repair creates or continues an unsafe condition.

Reasons to Suggest Repair or Replacement

1 - Part is close to the end of its useful life (just above discard specifications, or weak; failure likely to occur soon, etc.)

2 - To address a customer need, convenience, or request (to stiffen ride, enhance performance, eliminate noise, etc.)

3 - To comply with maintenance recommended by the vehicle's Original Equipment Manufacturer (OEM)

4 - Technician's recommendation based on substantial and informed experience

NOTE: Suggested services are always optional. When presenting suggested repairs to the customer, you must present the facts, allowing the customer to draw their own conclusions and make an informed decision about how to proceed.

ELECTRICAL SYSTEMS

SERVICE PROCEDURES REQUIRED AND SUGGESTED FOR PROPER VEHICLE OPERATION

NOTE: When working on electrical systems, if a potentially hazardous condition is observed, require repair or replacement of affected components prior to performing further work.

ACTUATOR MOTORS (SOLENOIDS) (ELECTRIC)

ACTUATOR MOTOR (SOLENOIDS) (ELECTRIC) INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Connector broken	A	Require repair or replacement.
Connector (Weatherpack type) leaking	A	Require repair or replacement.

Connector melted	A	(1) Require repair or replacement.
Connector missing	C	Require replacement.
Inoperative	A	(2) Require replacement.
Linkage bent, affecting performance	A	Require repair or replacement of linkage.
Linkage bent, not affecting performance	2	Suggest repair or replacement of linkage.
Linkage binding, affecting performance	A	Require repair or replacement of linkage.
Linkage binding, not affecting performance	1	Suggest repair or replacement of linkage.
Linkage broken	A	Require repair or replacement of linkage.
Linkage loose, affecting performance	A	Require repair or replacement of linkage.
Linkage loose, not affecting performance	1	Suggest repair or replacement of linkage.
Linkage missing	C	Require replacement.
Linkage noisy	2	Suggest repair or replacement.
Missing	C	Require replacement.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(1) Require repair or replacement.
Terminal burned, not affecting performance	1	(1) Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	1	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.
Missing	C	Require replacement.
Noisy	2	Suggest repair or replacement.
Out of adjustment	B	Require repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - Inoperative includes intermittent operation or out of OEM specification.

ACTUATOR MOTORS (VACUUM)

ACTUATOR MOTOR (VACUUM) INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of

		hardware.
Attaching hardware not functioning	A	... Require repair or replacement of hardware.
Connector broken	A	.. Require repair or replacement.
Connector (Weatherpack type) leaking	A	.. Require repair or replacement.
Connector melted	A	.... (1) Require repair or replacement.
Connector missing	C	.... Require replacement.
Inoperative	A	.... (2) Require replacement.
Leaking (vacuum)	A	.. Require repair or replacement.
Linkage bent, affecting performance ..	A	... Require repair or replacement of linkage.
Linkage bent, not affecting performance ..	2	... Suggest repair or replacement of linkage.
Linkage binding, affecting performance ..	A	... Require repair or replacement of linkage.
Linkage binding, not affecting performance ..	1	.. Suggest repair or replacement of linkage.
Linkage broken	A	... Require repair or replacement of linkage.
Linkage loose, affecting performance	A	... Require repair or replacement of linkage.
Linkage loose, not affecting performance ..	1	... Suggest repair or replacement of linkage.
Linkage missing	C	.... Require replacement.
Linkage noisy	2	.. Suggest repair or replacement.
Missing	C	.... Require replacement.
Noisy	2	.. Suggest repair or replacement.
Out of adjustment	A	.. Require repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - Inoperative includes intermittent operation or out of OEM specification.

AIR BAGS

For all air bag components and conditions, refer to vehicle manufacturer's specifications for diagnosis and parts replacement.

ALTERNATORS AND GENERATORS

NOTE: If components have been added that increase vehicle electrical load requirement (for example, sound systems, air conditioning, alarm systems, etc.), charging system output must meet the increased demand.

ALTERNATOR AND GENERATOR INSPECTION

Condition	Code	Procedure
Alternator output meets OEM specification but is insufficient for add-on		

electrical load	2	Suggest upgrade of alternator or removal of excess electrical load.
Alternator's rated output is below OEM specification	B	Require replacement.
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware non-functioning	A	Require repair or replacement of hardware.
Connector broken	A	Require repair or replacement.
Connector (Weatherpack type) leaking	A	Require repair or replacement.
Connector melted	A	(1) Require repair or replacement.
Connector missing	C	Require replacement.
Diode inoperative	A	(2) Require repair or replacement.
Housing broken, affecting performance	A	Require repair or replacement.
Housing broken, not affecting performance	..	No service suggested or required.
Housing cracked, affecting performance	A	Require repair or replacement.
Housing cracked, not affecting performance	1	Suggest repair or replacement.
Inoperative	A	(2) Require repair or replacement.
Noisy	2	Suggest repair or replacement.
Pulley incorrect	B	Require replacement.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(1) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.
Terminal resistance (voltage drop) out of specification	A	Require repair or replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.
Voltage drop out of specification	A	Require repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - Inoperative includes intermittent operation or out of OEM specification.

AMPLIFIERS

See RECEIVERS, AMPLIFIERS, EQUALIZERS AND SUB-WOOFER VOLUME CONTROLS.

ANTENNAS

ANTENNA INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Broken	A	Require replacement.
Bent	2	Suggest repair or replacement.
Binding	2	Suggest repair or replacement.
Connector broken	A	Require repair or replacement.
Connector melted	A	(1) Require repair or replacement.
Connector missing	C	Require replacement.
Inoperative	A	(2) Require replacement.
Insulation damaged, conductors exposed	A	Require repair or replacement.
Insulation damaged, conductors not exposed	1	Suggest replacement.
Missing	C	Require replacement.
Motor runs continuously	A	Require or replacement.
Power antenna noisy	2	Suggest repair or replacement.
Sticking	2	Suggest repair or replacement.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(1) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - Inoperative includes intermittent operation or out of specification.

BATTERIES

Proper operation of any electrical system or component can be affected by battery condition. The battery(ies) must meet or exceed

minimum specification for vehicle as equipped and test to that specific battery's CCA.

Definition of Terms

* Battery Performance Testing
  Testing that determines whether or not a battery meets both vehicle OEM and battery manufacturer's specifications.

* Cold Cranking Amp (CCA) Rating
  The number of amperes a new, fully charged battery at 0° F (-17.8° C) can deliver for 30 seconds and maintain at least a voltage of 1.2 volts per cell (7.2 volts for a 12-volt battery).

* Cranking Amps (CA)
  The number of amperes a new, fully charged battery, typically at 32° F (0° C) can deliver for 30 seconds and maintain at least a voltage of 1.2 volts per cell (7.2 volts for a 12-volt battery).

* OEM Cranking Amps
  The minimum CCA required by the original vehicle manufacturer for a specific vehicle.

BATTERY INSPECTION

Condition	Code	Procedure
Battery frozen	..	(1) Further inspection required.
Case leaking	A	Require replacement.
Casing swollen	A	(2) Further inspection required.
Circuit open internally	A	Require replacement.
Electrolyte contamination	A	(2) Further inspection required.
Electrolyte discoloration	A	(2) Further inspection required.
Fails to accept and hold charge	A	(3) Require replacement.
Fluid level low	B	(4) Further inspection required.
Out of performance specification for battery	B	(5) Require replacement.
Out of specification for application	B	(5) Require replacement.
Post (top or side) burned, affecting performance	A	(6) Require repair or replacement.
Post (top or side) burned, not affecting performance	2	(6) Suggest repair or replacement.
Post (top or side) corroded, affecting performance	A	Require repair.
Post (top or side) corroded, not affecting performance	2	Suggest repair.

Condition	Code	Procedure
Post (top or side) loose	A	Require replacement.
Post (top or side) melted, affecting performance	A	(6) Require repair or replacement.
Post (top or side) melted, not affecting performance	2	(6) Suggest repair or replacement.
Specific gravity low	B	(7) Further inspection required.
State of charge low	A	(7) Further inspection required.
Top dirty	2	Suggest cleaning battery.
Top wet	A	(8) Require cleaning battery. Further inspection required.
Vent cap loose	A	Require repair or replacement of vent cap.
Vent cap missing	C	Require replacement of vent cap.

(1) - DO NOT attempt to charge a frozen battery. Allow battery to warm thoroughly and then performance-test. If battery fails performance test, require replacement.
(2) - No service suggested or required unless the battery fails performance test, in which case, require replacement.
(3) - This phrase refers to a battery that fails to either accept and/or retain a charge using appropriate times listed in the Battery Charging Guide of the BCI Service Manual, battery charger operating manual, or battery manufacturer's specifications.
(4) - Determine cause of low fluid level. Refill to proper level(s) with water (distilled water preferred). Recharge battery and performance-test. If battery does not meet specifications, require replacement. If battery is sealed type (non-removable filler caps), require replacement.
(5) - The battery may meet battery manufacturer's specifications but test below the minimum specification defined by the vehicle's OEM for that vehicle.
(6) - Determine cause and correct prior to repair or replacement of part.
(7) - Recharge and test to manufacturer's specifications. If battery fails performance test, require replacement.
(8) - Check fluid level and adjust to manufacturer's specification. Suggest checking charging system for proper operation.

BATTERY CABLES

See BATTERY CABLES, WIRES AND CONNECTORS.

BATTERY CABLES, WIRES AND CONNECTORS

BATTERY CABLE, WIRE AND CONNECTOR INSPECTION

Condition	Code	Procedure
Application incorrect	B	Require repair or replacement.
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware		

missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Connector broken	A	Require repair or replacement.
Connector melted	A	(1) Require repair or replacement.
Connector missing	C	Require replacement.
Insulation damaged, conductors exposed	A	(2) Require repair or replacement.
Insulation damaged, conductors not exposed	1	Suggest replacement.
Open	A	Require repair or replacement.
Protective shield (conduit) melted	2	(1) Suggest repair or replacement.
Protective shield (conduit) missing	2	Suggest repair or replacement.
Resistance (voltage drop) out of specification	A	Require repair or replacement.
Routed incorrectly	B	Require repair.
Secured incorrectly	B	Require repair.
Shorted	A	Require repair or replacement.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(1) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.
Voltage drop out of specification	A	Require repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - Exposed conductor at replacement (aftermarket) terminal end does not require repair or replacement.

BATTERY HOLD DOWN HARDWARE

See BATTERY TRAYS AND HOLD DOWN HARDWARE.

BATTERY TRAYS AND HOLD DOWN HARDWARE

BATTERY TRAY AND HOLD DOWN HARDWARE INSPECTION

Condition	Code	Procedure
Battery improperly secured	2	Suggest repair.
Bent, affecting performance	A	Require repair or replacement.
Bent, not affecting		

performance	..	No service suggested or required.
Broken, affecting performance	A	Require repair or replacement.
Broken, not affecting performance	..	No service suggested or required.
Corroded, affecting performance	A	Require repair or replacement.
Corroded, not affecting performance	2	Suggest repair or replacement.
Cracked, affecting performance	A	Require repair or replacement.
Cracked, not affecting performance	1	Suggest repair or replacement.
Missing	C	Require replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.
Water drain clogged	A	Require repair.

BATTERY WIRES

See BATTERY CABLES, WIRES AND CONNECTORS.

BELTS

BELT INSPECTION

Condition	Code	Procedure
Alignment incorrect	B	(1) Further inspection required.
Cracked	1	Suggest replacement.
Frayed	1	Suggest replacement.
Missing	C	Require replacement.
Noisy	2	(2) Further inspection required.
Plies separated	A	Require replacement.
Tension out of specification	B	Require adjustment or replacement.
Worn beyond adjustment range	B	Require replacement.
Worn so it contacts bottom of pulley	A	Require replacement.

(1) - Determine cause of incorrect alignment and require repair.
(2) - Determine cause of noise and suggest repair.

BULB SOCKETS

BULB SOCKET INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of

Condition	Code	Procedure
		hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Bulb seized in socket	A	Require repair or replacement.
Burned, affecting performance	A	(1) Require repair or replacement.
Burned, not affecting performance	2	(1) Suggest repair or replacement.
Broken	A	Require repair or replacement.
Connector broken	A	Require repair or replacement.
Connector missing	C	Require replacement.
Connector (Weatherpack type) leaking	A	Require repair or replacement.
Connector melted	A	(1) Require repair or replacement.
Corroded, affecting performance	A	Require repair or replacement.
Corroded, not affecting performance	2	Suggest repair or replacement.
Leaking	A	Require repair or replacement.
Melted	A	(2) Require replacement.
Shorted	A	Require repair or replacement.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(2) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of socket.
(2) - Determine cause and correct prior to replacement of part.

BULBS, SEALED BEAMS AND LEDS

NOTE: Does not include soldered-in components.

BULB, SEALED BEAM AND LED INSPECTION

Condition	Code	Procedure
Adjustment out of specification	B	Require repair or replacement.
Application incorrect	B	(1) Require replacement.
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not		

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 functioning  ...........  A  ...  Require repair or replacement
                                                  of hardware.
Base burned, affecting
 performance  ...........  A  ..........  (2) Require repair or
                                                  replacement.
Base burned, not affecting
 performance  ...........  2  ..........  (2) Suggest repair or
                                                  replacement.
Base corroded, affecting
 performance  ...........  A  ..  Require repair or replacement.
Base corroded, not
 affecting performance  ..  2  ..  Suggest repair or replacement.
Base leaking  ...........  A  ..  Require repair or replacement.
Base loose, affecting
 performance  ...........  B  ..  Require repair or replacement.
Base loose, not affecting
 performance  ...........  1  ..  Suggest repair or replacement.
Base melted  ............  A  ........  (2) Require replacement.
Bracket bent, affecting
 performance  ...........  A  ..  Require repair or replacement.
Bracket bent, not
 affecting performance  ..  ..  ........  No service suggested or
                                                     required.
Bracket broken, affecting
 performance  ...........  A  ...........  Require replacement.
Bracket broken, not
 affecting performance  ..  ..  ........  No service suggested or
                                                     required.
Bracket corroded,
 affecting performance  ..  A  ..  Require repair or replacement.
Bracket corroded, not
 affecting performance  ..  2  ..  Suggest repair or replacement.
Bracket cracked, affecting
 performance  ...........  A  ..  Require repair or replacement.
Bracket cracked, not
 affecting performance  ..  1  ..  Suggest repair or replacement.
Bracket loose, affecting
 performance  ...........  A  ..  Require repair or replacement.
Bracket loose, not
 affecting performance  ..  1  ..  Suggest repair or replacement.
Bracket missing  .........  C  ...........  Require replacement.
Burned out  .............  A  ...........  Require replacement.
Connector broken  ........  A  ..  Require repair or replacement.
Connector (Weatherpack
 type) leaking  ..........  A  ..  Require repair or replacement.
Connector melted  ........  A  ..........  (2) Require repair or
                                                  replacement.
Connector missing  .......  C  ...........  Require replacement.
Corroded, affecting
 performance  ...........  A  ..  Require repair or replacement.
Corroded, not affecting
 performance  ...........  2  ..  Suggest repair or replacement.
Cracked  ................  A  ...........  Require replacement.
Intermittent  ...........  A  ...........  Require replacement.
Lamp base melted  ........  A  ........  (2) Require replacement.
Leaking  ................  A  ..  Require repair or replacement.
Missing  ................  C  ...........  Require replacement.
Seized in socket  ........  A  ..  Require repair or replacement.
Terminal broken  .........  A  ..  Require repair or replacement.
Terminal burned, affecting
 performance  ...........  A  ..........  (2) Require repair or
                                                  replacement.
Terminal burned, not
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affecting performance ..	2	.... (2) Suggest repair or replacement.
Terminal corroded, affecting performance ..	A	.. Require repair or replacement.
Terminal corroded, not affecting performance ..	2	.. Suggest repair or replacement.
Terminal loose, affecting performance	B	.. Require repair or replacement.
Terminal loose, not affecting performance ..	1	.. Suggest repair or replacement.
Threads damaged	A	.. Require repair or replacement.
Threads stripped (threads missing)	A	.... Require replacement.

(1) - Application incorrect includes wrong bulb coating or color.
(2) - Determine cause and correct prior to repair or replacement of part.

CD PLAYERS

See TAPE PLAYERS AND CD PLAYERS.

CIGARETTE LIGHTER ASSEMBLIES

CIGARETTE LIGHTER ASSEMBLY INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	... Require repair or replacement of hardware.
Attaching hardware missing	C	.... Require replacement of hardware.
Attaching hardware not functioning	A	... Require repair or replacement of hardware.
Inoperative	A	.... (1) Require repair or replacement.
Loose	A	.. Require repair or replacement.
Missing	2	.... Suggest replacement.
Sticking	A	.. Require repair or replacement.
Terminal broken	A	.. Require repair or replacement.
Terminal burned, affecting performance	A	.... (2) Require repair or replacement.
Terminal burned, not affecting performance ..	2	.. Suggest repair or replacement.
Terminal corroded, affecting performance ..	A	.. Require repair or replacement.
Terminal corroded, not affecting performance ..	2	.. Suggest repair or replacement.
Terminal loose, affecting performance	B	.. Require repair or replacement.
Terminal loose, not affecting performance ..	1	.. Suggest repair or replacement.

(1) - Inoperative includes intermittent operation or out of OEM specification.
(2) - Determine cause and correct prior to repair or replacement of part.

CIRCUIT BREAKERS

See FUSES, FUSIBLE LINKS AND CIRCUIT BREAKERS.

CLUTCH SWITCHES

See SWITCHES.

CONNECTORS

See WIRING HARNESSES AND CONNECTORS.

CONTROL MODULES

CONTROL MODULE INSPECTION

Condition	Code	Procedure
Application incorrect	B	Require replacement.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware threads damaged	A	Require repair or replacement of hardware.
Attaching hardware threads stripped (threads missing)	A	Require repair or replacement of hardware.
Code set (if applicable)	A	(1) Further inspection required.
Connector broken	A	Require repair or replacement.
Connector melted	A	(2) Require repair or replacement.
Connector missing	A	Require repair.
Contaminated	A	(3) Require repair or replacement.
Inoperative	B	(4) Require repair or replacement. Further inspection required.
Leaking	A	Require repair or replacement.
Missing	C	Require replacement.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(2) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.

Wire lead conductors exposed	B	Require repair or replacement.
Wire lead corroded	A	Require repair or replacement.
Wire lead open	A	Require repair or replacement.
Wire lead shorted	A	Require repair or replacement.

(1) - Refer to manufacturer's diagnostic trouble code procedure and require repair or replacement of affected component(s).
(2) - Determine cause and correct prior to repair or replacement of part.
(3) - Determine source of contamination, such as engine coolant, fuel, metal particles, or water. Require repair or replacement.
(4) - Inoperative includes intermittent operation or out of OEM specification. Some components may be serviceable; check for accepted cleaning procedure.

CRUISE CONTROL BRAKE SWITCHES

See SWITCHES.

CRUISE CONTROL CABLES

See CRUISE CONTROL LINKAGES AND CABLES.

CRUISE CONTROL CLUTCH SWITCHES

See SWITCHES.

CRUISE CONTROL LINKAGES AND CABLES

CRUISE CONTROL LINKAGE AND CABLE INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Bent	A	Require repair or replacement.
Binding	A	Require repair or replacement.
Bracket bent, affecting performance	A	Require repair or replacement.
Bracket bent, not affecting performance	..	No service suggested or required.
Bracket broken, affecting performance	A	Require replacement.
Bracket broken, not affecting performance	..	No service suggested or required.
Bracket corroded, affecting performance	A	Require repair or replacement.
Bracket corroded, not affecting performance	2	Suggest repair or replacement.

Bracket cracked, affecting performance	A	Require repair or replacement.
Bracket cracked, not affecting performance	1	Suggest repair or replacement.
Bracket loose, affecting performance	A	Require repair or replacement.
Bracket loose, not affecting performance	1	Suggest repair or replacement.
Bracket missing	C	Require replacement.
Broken	A	Require replacement.
Cracked	A	Require repair or replacement.
Disconnected	A	Require repair or replacement.
Kinked	A	Require repair or replacement.
Melted	A	(1) Require repair or replacement.
Missing	C	Require replacement.
Noisy	2	Suggest repair or replacement.
Out of adjustment	B	(2) Require repair or replacement.
Routed incorrectly	2	Suggest repair.
Seized	A	Require repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - Follow OEM recommended adjustment procedures. Require repair or replacement if out of specification.

CRUISE CONTROL RESERVOIRS

See CRUISE CONTROL VACUUM HOSES, TUBES AND RESERVOIRS.

CRUISE CONTROL TUBES

See CRUISE CONTROL VACUUM HOSES, TUBES AND RESERVOIRS.

CRUISE CONTROL VACUUM DUMP RELEASE VALVES

CRUISE CONTROL VACUUM DUMP RELEASE VALVE INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Broken	A	Require repair or replacement.
Inoperative	A	(1) Require replacement.
Leaking	2	Suggest replacement.
Out of adjustment	B	(2) Further inspection required.

(1) - Inoperative includes intermittent operation or out of OEM specification.
(2) - Follow OEM recommended adjustment procedures. Require repair or replacement if out of specification.

CRUISE CONTROL VACUUM HOSES, TUBES AND RESERVOIRS

CRUISE CONTROL VACUUM HOSE, TUBE AND RESERVOIR INSPECTION

Condition	Code	Procedure
Leaking	A	Require repair or replacement.
Melted	A	Require replacement.
Missing	C	Require replacement.
Oil-soaked (spongy)	1	Suggest replacement.
Restricted	A	Require repair or replacement.
Surface cracks (dry-rotted)	1	Suggest replacement.

CRUISE CONTROL VEHICLE SPEED SENSORS

CRUISE CONTROL VEHICLE SPEED SENSOR INSPECTION

Condition	Code	Procedure
Air gap incorrect	B	(1) Require adjustment to vehicle manufacturer's specifications.
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Broken	A	Require replacement.
Housing cracked	A	Require replacement.
Internal resistance does not meet specifications	B	(2) Require replacement.
Lead routing incorrect	B	Require rerouting according to vehicle manufacturer's specifications.
Loose	B	(3) Require adjustment to vehicle manufacturer's specifications.
Missing	C	Require replacement.
Output signal incorrect	B	(2) Require repair or replacement.
Surface contaminated	2	Suggest cleaning; identify and correct source.
Tip bent	B	Require replacement.
Tip broken	B	Require replacement.
Tip missing	B	Require replacement.
Wire lead burned	A	Require replacement.
Wire lead conductors exposed	B	Require replacement.
Wire lead corroded	A	Require replacement.
Wire lead open	A	Require replacement.
Wire lead shorted	A	Require replacement.

(1) - If a sensor is not adjustable, further inspection is required to identify and correct cause.
(2) - Component failure may be caused by water intrusion into the wiring harness. Always check insulation for damage

and wiring for excessive resistance.
(3) - Some integral bearing assemblies with sensors may require replacement.

DEFOGGERS

See HEATING ELEMENTS (DEFROSTERS, DEFOGGERS, ELECTRIC HEATERS AND SEATS).

DEFROSTERS

See HEATING ELEMENTS (DEFROSTERS, DEFOGGERS, ELECTRIC HEATERS AND SEATS).

DELAYS

DELAY INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Binding, affecting performance	A	Require repair or replacement.
Binding, not affecting performance	2	Suggest repair or replacement.
Broken	A	Require repair or replacement.
Burned, affecting performance	A	(1) Require repair or replacement.
Burned, not affecting performance	2	(1) Suggest repair or replacement.
Cracked, affecting performance	A	Require repair or replacement.
Cracked, not affecting performance	1	Suggest repair or replacement.
Inoperative	A	(2) Require repair or replacement.
Melted, affecting performance	A	(1) Require repair or replacement.
Melted, not affecting performance	2	(1) Suggest repair or replacement.
Missing	C	Require replacement.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(1) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not		

affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - Inoperative includes intermittent operation or out of OEM specification.

DIMMERS

DIMMER INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Binding, affecting performance	A	Require repair or replacement.
Binding, not affecting performance	2	Suggest repair or replacement.
Broken	A	Require repair or replacement.
Burned, affecting performance	A	(1) Require repair or replacement.
Burned, not affecting performance	2	(1) Suggest repair or replacement.
Cracked, affecting performance	A	Require repair or replacement.
Cracked, not affecting performance	1	Suggest repair or replacement.
Inoperative	A	(2) Require repair or replacement.
Melted, affecting performance	A	(1) Require repair or replacement.
Melted, not affecting performance	2	(1) Suggest repair or replacement.
Missing	C	Require replacement.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(1) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.

Terminal loose, not affecting performance	1	Suggest repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - Inoperative includes intermittent operation or out of OEM specification.

ELECTRIC HEATERS

See HEATING ELEMENTS (DEFROSTERS, DEFOGGERS, ELECTRIC HEATERS AND SEATS).

EQUALIZERS

See RECEIVERS, AMPLIFIERS, EQUALIZERS AND SUB-WOOFER VOLUME CONTROLS.

FUSE BLOCKS

See FUSE BOXES AND BLOCKS.

FUSE BOXES AND BLOCKS

FUSE BOX AND BLOCK INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Broken, affecting performance	A	Require replacement.
Broken, not affecting performance	..	No service suggested or required.
Burned, affecting performance	A	(1) Require repair or replacement.
Burned, not affecting performance	2	(1) Suggest repair or replacement.
Connector broken	A	Require repair or replacement.
Connector (Weatherpack type) leaking	A	Require repair or replacement.
Connector melted	A	(1) Require repair or replacement.
Connector missing	C	Require replacement.
Cover missing	C	Require replacement of cover.
Cracked, affecting performance	A	Require repair or replacement.
Cracked, not affecting performance	1	Suggest repair or replacement.
Melted, affecting performance	A	(1) Require replacement.

Melted, not affecting performance	2	(1) Suggest replacement.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(1) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.

FUSES, FUSIBLE LINKS AND CIRCUIT BREAKERS

FUSE, FUSIBLE LINK AND CIRCUIT BREAKER INSPECTION

Condition	Code	Procedure
Application incorrect	B	Require replacement.
Blown	A	(1) Require replacement.
Corroded, affecting performance	A	Require repair or replacement.
Corroded, not affecting performance	2	Suggest repair or replacement.
Cracked, affecting performance	A	Require repair or replacement.
Cracked, not affecting performance	1	Suggest repair or replacement.
Inoperative	A	(2) Require replacement.
Insulation damaged, conductors exposed	A	Require repair or replacement.
Insulation damaged, conductors not exposed	1	Suggest replacement.
Missing	C	Require replacement.
Routed incorrectly	B	Require repair.
Secured incorrectly	B	Require repair.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(1) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - Inoperative includes intermittent operation.

FUSIBLE LINKS

See FUSES, FUSIBLE LINKS AND CIRCUIT BREAKERS.

GAUGES

NOTE: Includes odometers, speedometers and tachometers (except cable-driven).

GAUGE INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Connector broken	A	Require repair or replacement.
Connector (Weatherpack type) leaking	A	Require repair or replacement.
Connector melted	A	(1) Require repair or replacement.
Connector missing	C	Require replacement.
Leaking	A	Require replacement.
Lens broken	A	(2) Require repair or replacement.
Lens cloudy	2	(2) Suggest repair or replacement.
Lens missing	C	(2) Require repair or replacement.
Malfunctioning	A	(3) Require repair or replacement.
Mechanical head noisy	2	Suggest repair or replacement.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(1) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - If lens is available as a separate part, require replacement of lens only.
(3) - Includes inoperative, intermittent operation, failure to perform all functions, out of OEM specification, or out of range.

GENERATORS

See ALTERNATORS AND GENERATORS.

GROUND CABLES AND STRAPS

GROUND CABLE AND STRAP INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Corroded, affecting performance	A	Require repair or replacement.
Corroded, not affecting performance	2	Suggest repair or replacement.
Insulation damaged, exposing conductors	2	Suggest replacement.
Loose	A	Require repair.
Missing	C	Require replacement.
Open	A	Require repair or replacement.
Resistance high	A	Require repair or replacement.
Terminal resistance (voltage drop) is out of specification	B	Require repair or replacement.
Voltage drop out of specification	B	Require repair or replacement.

GROUND STRAPS

See GROUND CABLES AND STRAPS.

HEADLIGHT ADJUSTERS

HEADLIGHT ADJUSTER INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Bent, preventing adjustment	A	Require repair or replacement.
Broken	A	Require repair or replacement.
Indicator broken	A	Require replacement.
Indicator missing	C	Require replacement.
Missing	C	Require replacement of

		adjusters.
Seized	A	Require repair or replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.

HEATING ELEMENTS (DEFROSTERS, DEFOGGERS, ELECTRIC HEATERS AND SEATS)

HEATING ELEMENT (DEFROSTER, DEFOGGER, ELECTRIC HEATER AND SEAT) INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Connector broken	A	Require repair or replacement.
Connector (Weatherpack type) leaking	A	Require repair or replacement.
Connector melted	A	(1) Require repair or replacement.
Connector missing	C	Require replacement.
Inoperative	A	(2) Require repair or replacement.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(1) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.
Wire lead burned	A	Require repair or replacement.
Wire lead conductors exposed	B	Require repair or replacement.
Wire lead open	A	Require repair or replacement.
Wire lead shorted	A	Require repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - Inoperative includes intermittent operation or out of OEM specification.

HORNS AND SIRENS

HORN AND SIREN INSPECTION

Condition	Code	Procedure

Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Connector broken	A	Require repair or replacement.
Connector melted	A	(1) Require repair or replacement.
Connector missing	C	Require replacement.
Inoperative	A	(2) Require repair or replacement.
Missing	C	Require replacement.
Out of adjustment	B	Require adjustment.
Sound quality poor	A	Require repair or replacement. Further inspection required.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(1) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.
Wire lead burned	A	Require repair or replacement.
Wire lead conductors exposed	B	Require repair or replacement.
Wire lead open	A	Require repair or replacement.
Wire lead shorted	A	Require repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - Inoperative includes intermittent operation.

IGNITION SWITCHES

See SWITCHES.

INDICATOR LIGHTS

INDICATOR LIGHT INSPECTION

Condition	Code	Procedure
Does not come on during bulb check	..	(1) Further inspection required.
Fails to function properly during test mode	..	(1) Further inspection required.
On constantly	..	(1) Further inspection required.

On intermittently		(1) Further inspection required.

(1) - See service manual for further information.

KEYLESS ENTRY KEYPADS AND TRANSMITTERS

KEYLESS ENTRY KEYPAD AND TRANSMITTER INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Connector broken	A	Require repair or replacement.
Connector (Weatherpack type) leaking	A	Require repair or replacement.
Connector melted	A	(1) Require repair or replacement.
Connector missing	C	Require replacement.
Malfunctioning	A	(2) Require repair or replacement.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(1) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.
Wire lead burned	A	Require repair or replacement.
Wire lead conductors exposed	B	Require repair or replacement.
Wire lead open	A	Require repair or replacement.
Wire lead shorted	A	Require repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - Malfunctioning includes inoperative, intermittent operation, or failure to perform all functions.

KEYLESS ENTRY TRANSMITTERS

See KEYLESS ENTRY KEYPADS AND TRANSMITTERS.

LEDS

See BULBS, SEALED BEAMS AND LEDS.

LENSES

LENSE INSPECTION

Condition	Code	Procedure
Adjustment out of specification	B	Require repair.
Application incorrect	A	Require replacement.
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Broken, affecting performance	A	Require replacement.
Broken, not affecting performance	..	No service suggested or required.
Cracked	A	Require replacement.
Discolored	A	Require replacement.
Leaking	A	Require repair or replacement.
Melted, affecting performance	A	Require replacement.
Melted, not affecting performance	2	Suggest replacement.
Missing	C	Require replacement.

MICROPHONES

See SPEAKERS AND MICROPHONES.

MIRRORS (ELECTROCHROMATIC AND HEATED)

MIRROR (ELECTROCHROMATIC AND HEATED) INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Broken	A	Require repair or replacement.
Connector broken	A	Require repair or replacement.
Connector melted	A	(1) Require repair or replacement.
Connector missing	C	Require replacement.
Cracked	A	Require replacement.
Inoperative	A	(2) Require replacement.
Missing	C	Require replacement.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(1) Require repair or

replacement.

Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.
Wire lead burned	A	Require repair or replacement.
Wire lead conductors exposed	B	Require repair or replacement.
Wire lead open	A	Require repair or replacement.
Wire lead shorted	A	Require repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - Inoperative includes intermittent operation.

MOTORS

MOTOR INSPECTION

Condition	Code	Procedure
Amperage draw out of specification	A	Require repair or replacement.
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Bracket bent	A	Require repair or replacement.
Bracket broken	A	Require repair or replacement.
Bracket cracked	A	Require repair or replacement.
Bracket holes elongated, affecting performance	A	Require repair or replacement.
Bracket holes elongated, not affecting performance	..	No service suggested or required.
Bracket missing	C	Require replacement.
Connector broken	A	Require repair or replacement.
Connector (Weatherpack type) leaking	A	Require repair or replacement.
Connector melted	A	(1) Require repair or replacement.
Connector missing	C	Require replacement.
Drive mechanism damaged, affecting performance	A	(2) Require repair or replacement.
Drive mechanism damaged, not affecting performance	2	(2) Suggest repair or replacement.
Fails to disengage	A	Require repair or replacement.

Housing broken, affecting performance	2	Suggest repair or replacement.
Housing broken, not affecting performance	..	No service suggested or required.
Housing cracked, affecting performance	A	Require repair or replacement.
Housing cracked, not affecting performance	1	Suggest repair or replacement.
Inoperative	A	(3) Require repair or replacement.
Linkage bent, affecting performance	A	Require repair or replacement of linkage.
Linkage bent, not affecting performance	..	No service suggested or required.
Linkage binding, affecting performance	A	Require repair or replacement of linkage.
Linkage binding, not affecting performance	2	Suggest repair or replacement of linkage.
Linkage broken	A	Require repair or replacement of linkage.
Linkage loose, affecting performance	A	Require repair or replacement of linkage.
Linkage loose, not affecting performance	1	Suggest repair or replacement of linkage.
Linkage missing	C	Require replacement.
Linkage noisy	2	Suggest repair or replacement.
Missing	C	Require replacement.
Noisy	2	Suggest repair or replacement.
Out of adjustment	B	(4) Further inspection required.
Resistance out of specification	A	Require repair or replacement.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(1) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.
Wire lead burned	A	Require repair or replacement.
Wire lead conductors exposed	B	Require repair or replacement.
Wire lead open	A	Require repair or replacement.
Wire lead shorted	A	Require repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - Further inspection required to determine cause.
(3) - Inoperative includes intermittent operation.

(4) - Follow OEM recommended adjustment procedures. Repair or replace if out of specification.

NEUTRAL SAFETY SWITCHES

See SWITCHES.

ODOMETERS

See GAUGES.

ODOMETERS, SPEEDOMETERS AND TACHOMETERS (CABLE-DRIVEN)

ODOMETER, SPEEDOMETER AND TACHOMETER (CABLE-DRIVEN) INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Connector broken	A	Require repair or replacement.
Connector (Weatherpack type) leaking	A	Require repair or replacement.
Connector melted	A	(1) Require repair or replacement.
Connector missing	C	Require replacement.
Drive cable broken	A	Require replacement.
Drive cable noisy	2	Suggest repair or replacement.
Inoperative	A	(2) Further inspection required.
Leaking	A	Require replacement.
Lens broken	A	(3) Require repair or replacement.
Lens cloudy	2	(3) Suggest repair or replacement.
Lens missing	C	(3) Require repair or replacement.
Noisy	2	Suggest repair or replacement.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(1) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - If lens is available as a separate part, require

replacement of lens only.
(3) - Includes inoperative, intermittent operation, failure to perform all functions, out of OEM specification, or out of range.

PULLEYS

PULLEY INSPECTION

Condition	Code	Procedure
Alignment incorrect	B	Require repair or replacement.
Application incorrect	B	Require replacement.
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Bent	A	Require replacement.
Cracked	A	Require replacement.
Loose	A	Require repair or replacement.
Missing	C	Require replacement.
Pulley damaged, affecting belt life	A	Require replacement.

RECEIVERS, AMPLIFIERS, EQUALIZERS AND SUB-WOOFER VOLUME CONTROLS

RECEIVER, AMPLIFIER, EQUALIZER AND SUB-WOOFER VOLUME CONTROL INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Connector broken	A	Require repair or replacement.
Connector melted	A	(1) Require repair or replacement.
Connector missing	C	Require replacement.
Malfunctioning	A	(2) Require repair or replacement.
Missing	C	Require replacement.
Sound quality poor	A	(3) Require repair or replacement.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(1) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.

Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.
Wire lead burned	A	Require repair or replacement.
Wire lead conductors exposed	B	Require repair or replacement.
Wire lead open	A	Require repair or replacement.
Wire lead shorted	A	Require repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - Malfunctioning includes inoperative, intermittent operation, or failure to perform all functions.
(3) - Make sure poor sound quality is not caused by ignition/charging system or other forms of electrical interference.

RELAY BOXES

RELAY BOX INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Broken, affecting performance	A	Require replacement.
Broken, not affecting performance	..	No service suggested or required.
Burned, affecting performance	A	(1) Require repair or replacement.
Burned, not affecting performance	2	(1) Suggest repair or replacement.
Connector broken	A	Require repair or replacement.
Connector (Weatherpack type) leaking	A	Require repair or replacement.
Connector melted	A	(1) Require repair or replacement.
Connector missing	C	Require replacement.
Cover missing	C	Require replacement of cover.
Cracked, affecting performance	A	Require repair or replacement.
Cracked, not affecting performance	1	Suggest repair or replacement.
Melted, affecting performance	A	(1) Require replacement.
Melted, not affecting		

performance	2	(1) Suggest replacement.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(1) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.

RELAYS

RELAY INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Housing broken	A	Require replacement.
Housing cracked	2	Suggest replacement.
Inoperative	A	(1) Require replacement.
Missing	C	Require replacement.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(2) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.

(1) - Inoperative includes intermittent operation or out of OEM specification.
(2) - Determine cause and correct prior to repair or replacement of part.

SEALED BEAMS

See BULBS, SEALED BEAMS AND LEDS.

SEAT HEATERS

See
HEATING ELEMENTS (DEFROSTERS, DEFOGGERS, ELECTRIC HEATERS AND SEATS).

SECURITY ALARM SENSORS

SECURITY ALARM SENSOR INSPECTION

Condition	Code	Procedure
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware threads damaged	A	Require repair or replacement of hardware.
Attaching hardware threads stripped (threads missing)	A	Require repair or replacement of hardware.
Connector broken	A	Require repair or replacement.
Connector melted	A	(1) Require repair or replacement.
Connector missing	C	Require replacement.
Inoperative	B	(2) Require repair or replacement. Further inspection required.
Missing	C	Require replacement.
Resistance out of specification	B	Require repair or replacement.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(1) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.
Wire lead conductors exposed	B	Require repair or replacement.
Wire lead corroded	A	Require repair or replacement.
Wire lead open	A	Require repair or replacement.
Wire lead shorted	A	Require repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - Inoperative includes intermittent operation or out of OEM specification.

SIRENS

See HORNS AND SIRENS.

SOLENOIDS

See ACTUATOR MOTORS (SOLENOIDS) (ELECTRIC).

NOTE: For starter solenoids that are integral to the starter assembly, see STARTERS.

NOTE: For starter relays, see RELAYS.

SPEAKERS AND MICROPHONES

SPEAKER AND MICROPHONE INSPECTION

Condition	Code	Procedure
Application incorrect	A	Require replacement.
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Connector broken	A	Require repair or replacement.
Connector (Weatherpack type) leaking	A	Require repair or replacement.
Connector melted	A	(1) Require repair or replacement.
Connector missing	C	Require replacement.
Inoperative	B	(2) Require repair or replacement. Further inspection required.
Membrane torn	A	Require replacement.
Missing	C	Require replacement.
Polarity reversed	A	Require repair.
Sound quality poor	A	(3) Require repair or replacement. Further inspection required.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(1) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - Inoperative includes intermittent operation or out of OEM specification.
(3) - Make sure poor sound quality is not caused by ignition/charging system or other forms of electrical

interference.

SPEEDOMETER AND TACHOMETER LINKAGES AND CABLES

SPEEDOMETER AND TACHOMETER LINKAGE AND CABLE INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Bent	A	Require repair or replacement.
Binding	A	Require repair or replacement.
Bracket bent, affecting performance	A	Require repair or replacement.
Bracket bent, not affecting performance	..	No service suggested or required.
Bracket broken, affecting performance	A	Require replacement.
Bracket broken, not affecting performance	..	No service suggested or required.
Bracket corroded, affecting performance	A	Require repair or replacement.
Bracket corroded, not affecting performance	2	Suggest repair or replacement.
Bracket cracked, affecting performance	A	Require repair or replacement.
Bracket cracked, not affecting performance	1	Suggest repair or replacement.
Bracket loose, affecting performance	A	Require repair or replacement.
Bracket loose, not affecting performance	1	Suggest repair or replacement.
Bracket missing	C	Require replacement.
Broken	A	Require replacement.
Cracked	A	Require repair or replacement.
Disconnected	A	Require repair or replacement.
Kinked	A	Require repair or replacement.
Melted	A	(1) Require repair or replacement.
Missing	C	Require replacement.
Noisy	2	Suggest repair or replacement.
Routed incorrectly	2	Suggest repair.
Seized	A	Require repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.

SPEEDOMETER CABLES

See SPEEDOMETER AND TACHOMETER LINKAGES AND CABLES.

SPEEDOMETERS

See GAUGES.

STARTERS

NOTE: To prevent misdiagnosis, care should be taken to eliminate the possibilities of mechanical problems or high resistance in power and/or ground circuits.

STARTER INSPECTION

Condition	Code	Procedure
Amperage draw does not meet OEM specifications	B	Require repair or replacement.
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	(1) Require repair or replacement of hardware.
Bracket bent, affecting performance	A	Require repair or replacement.
Bracket bent, not affecting performance	..	No service suggested or required.
Bracket broken, affecting performance	A	Require replacement.
Bracket broken, not affecting performance	..	No service suggested or required.
Bracket corroded, affecting performance	A	Require repair or replacement.
Bracket corroded, not affecting performance	2	Suggest repair or replacement.
Bracket cracked, affecting performance	A	Require repair or replacement.
Bracket cracked, not affecting performance	1	Suggest repair or replacement.
Bracket holes elongated, affecting performance	A	Require repair or replacement.
Bracket holes elongated, not affecting performance)	..	No service suggested or required.
Bracket loose, affecting performance	A	Require repair or replacement.
Bracket loose, not affecting performance	1	Suggest repair or replacement.
Bracket missing	C	Require replacement.
Drive gear damaged, affecting performance	A	(2) Require repair or replacement.
Drive gear damaged, not affecting performance	2	(2) Suggest repair or replacement.
Fails to disengage	A	Require repair or replacement.
Housing broken, affecting performance	2	Require repair or replacement.
Housing broken, not		

affecting performance		No service suggested or required.
Housing cracked, affecting performance	A	... Require repair or replacement.
Housing cracked, not affecting performance ..	2	.. Suggest repair or replacement.
Inoperative	A	.... (3) Require repair or replacement.
Noisy	2	.. Suggest repair or replacement.
Shimmed incorrectly	B	.... Require repair.
Starter shaft bushing missing	C	.... (4) Require replacement.
Starter shaft bushing worn, affecting performance	A	.... Require replacement.
Starter shaft bushing worn, not affecting performance	1	.... Suggest replacement.
Terminal broken	A	.. Require repair or replacement.
Terminal burned, affecting performance	A	.... (5) Require repair or replacement.
Terminal burned, not affecting performance ..	2	.. Suggest repair or replacement.
Terminal corroded, affecting performance ..	A	.. Require repair or replacement.
Terminal corroded, not affecting performance ..	2	.. Suggest repair or replacement.
Terminal loose, affecting performance	B	.. Require repair or replacement.
Terminal loose, not affecting performance ..	1	.. Suggest repair or replacement.

(1) - Inspect block or bell housing mounting surface.
(2) - Further inspection required to determine cause. Require inspection of ring gear.
(3) - Inoperative includes intermittent operation.
(4) - Bushing may be in bell housing.
(5) - Determine cause and correct prior to repair or replacement of part.

SUB-WOOFER VOLUME CONTROLS

See
RECEIVERS, AMPLIFIERS, EQUALIZERS AND SUB-WOOFER VOLUME CONTROLS .

SWITCHES

SWITCH INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	... Require repair or replacement of hardware.
Attaching hardware missing	C	.... Require replacement of hardware.
Attaching hardware not functioning	A	... Require repair or replacement of hardware.
Binding, affecting		

performance	A	Require repair or replacement.
Binding, not affecting performance	2	Suggest repair or replacement.
Broken	A	Require repair or replacement.
Burned, affecting performance	A	(1) Require repair or replacement.
Burned, not affecting performance	2	(1) Suggest repair or replacement.
Cracked, affecting performance	A	Require repair or replacement.
Cracked, not affecting performance	1	Suggest repair or replacement.
Leaking	A	Require repair or replacement.
Malfunctioning	A	(2) Require repair or replacement.
Melted, affecting performance	A	(1) Require repair or replacement.
Melted, not affecting performance	2	(1) Suggest repair or replacement.
Missing	C	Require replacement.
Out of adjustment	B	Require repair or replacement.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(1) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.
Won't return	A	Require repair or replacement.
Worn	1	Suggest replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - Includes inoperative, intermittent operation, or failure to perform all functions.

TACHOMETER CABLES

See SPEEDOMETER AND TACHOMETER LINKAGES AND CABLES.

TACHOMETERS

See GAUGES.

TAPE PLAYERS AND CD PLAYERS

TAPE PLAYER AND CD PLAYER INSPECTION

Condition	Code	Procedure
Attaching hardware		

broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Connector broken	A	Require repair or replacement.
Connector melted	A	(1) Require repair or replacement.
Connector missing	C	Require replacement.
Malfunctioning	A	(2) Require repair or replacement.
Missing	C	Require replacement.
Skips	A	Require repair or replacement.
Sound quality poor	A	(3) Require repair or replacement.
Speed incorrect	A	Require repair or replacement.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(1) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.
Wire lead burned	A	Require repair or replacement.
Wire lead conductors exposed	B	Require repair or replacement.
Wire lead open	A	Require repair or replacement.
Wire lead shorted	A	Require repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - Malfunctioning includes inoperative, intermittent operation, or failure to perform all functions.
(3) - Make sure poor sound quality is not caused by ignition/charging system or other forms of electrical interference.

TENSIONERS

TENSIONER INSPECTION

Condition	Code	Procedure
Alignment incorrect	B	Require repair or replacement.
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement

		of hardware.
Bearings worn	1	Suggest replacement.
Belt tension incorrect	B	Require adjustment or repair.
Cracked	2	Suggest replacement.
Missing	C	Require replacement.
Noisy	2	Suggest replacement.
Pulley damaged, affecting belt life	A	Require replacement.
Seized	A	Require repair or replacement.

TIMERS

TIMER INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Broken	A	Require repair or replacement.
Burned, affecting performance	A	(1) Require repair or replacement.
Burned, not affecting performance	2	(1) Suggest repair or replacement.
Cracked, affecting performance	A	Require repair or replacement.
Cracked, not affecting performance	1	Suggest repair or replacement.
Inoperative	A	(2) Require repair or replacement.
Melted, affecting performance	A	(1) Require repair or replacement.
Melted, not affecting performance	2	(1) Suggest repair or replacement.
Missing	C	Require replacement.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(1) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.

(2) - Inoperative includes intermittent operation or out of OEM specification.

TIRE PRESSURE SENSORS

TIRE PRESSURE SENSOR INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Inoperative	A	(1) Require repair or replacement.
Loose	A	Require repair or replacement.
Missing	C	Require replacement.

(1) - Inoperative includes intermittent operation or out of OEM specification.

TRANSCEIVERS

TRANSCEIVER INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Connector broken	A	Require repair or replacement.
Connector melted	A	(1) Require repair or replacement.
Connector missing	C	Require replacement.
Malfunctioning	A	(2) Require repair or replacement.
Missing	C	Require replacement.
Sound quality poor	A	(3) Require repair or replacement.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(1) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting		

performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.
Wire lead burned	A	Require repair or replacement.
Wire lead conductors exposed	B	Require repair or replacement.
Wire lead open	A	Require repair or replacement.
Wire lead shorted	A	Require repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - Malfunctioning includes inoperative, intermittent operation, or failure to perform all functions.
(3) - Make sure poor sound quality is not caused by ignition/charging system or other forms of electrical interference.

TRANSDUCERS

TRANSDUCER INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Connector broken	A	Require repair or replacement.
Connector (Weatherpack type) leaking	A	Require repair or replacement.
Connector melted	A	(1) Require repair or replacement.
Connector missing	C	Require replacement.
Drive mechanism damaged, affecting performance	A	(2) Require repair or replacement.
Drive mechanism damaged, not affecting performance	2	(2) Suggest repair or replacement.
Inoperative	A	(3) Require repair or replacement.
Leaking (vacuum/fluid/air)	A	Require replacement.
Linkage bent, affecting performance	A	Require repair or replacement of linkage.
Linkage bent, not affecting performance	..	No service suggested or required.
Linkage binding, affecting performance	A	Require repair or replacement of linkage.
Linkage binding, not affecting performance	2	Suggest repair or replacement of linkage.
Linkage broken	A	Require repair or replacement

		of linkage.
Linkage loose, affecting performance	A	... Require repair or replacement of linkage.
Linkage loose, not affecting performance ..	1	... Suggest repair or replacement of linkage.
Linkage missing	C	.... Require replacement.
Linkage noisy	2	.. Suggest repair or replacement.
Out of adjustment	B	.... (4) Further inspection required.
Terminal broken	A	.. Require repair or replacement.
Terminal burned, affecting performance	A	.... (1) Require repair or replacement.
Terminal burned, not affecting performance ..	2	.. Suggest repair or replacement.
Terminal corroded, affecting performance ..	A	.. Require repair or replacement.
Terminal corroded, not affecting performance ..	2	.. Suggest repair or replacement.
Terminal loose, affecting performance	B	.. Require repair or replacement.
Terminal loose, not affecting performance ..	1	.. Suggest repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - Further inspection required to determine cause.
(3) - Inoperative includes intermittent operation or out of specification.
(4) - Follow OEM recommended adjustment procedures. Repair or replace if out of specification.

VACUUM ACCUMULATORS (RESERVOIRS)

VACUUM ACCUMULATOR (RESERVOIR) INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	... Require repair or replacement of hardware.
Attaching hardware missing	C	.... Require replacement of hardware.
Attaching hardware not functioning	A	... Require repair or replacement of hardware.
Leaking	A	.. Require repair or replacement.

VACUUM RESERVOIRS

See VACUUM ACCUMULATORS (RESERVOIRS).

VOLTAGE REGULATORS

VOLTAGE REGULATOR INSPECTION

Condition	Code	Procedure

Condition	Code	Procedure
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Connector broken	A	Require repair or replacement.
Connector (Weatherpack type) leaking	A	Require repair or replacement.
Connector melted	A	(1) Require repair or replacement.
Connector missing	C	Require replacement.
Inoperative	A	(2) Require replacement.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(1) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - NOTE: Inoperative includes intermittent operation or out of OEM specification.

WASHER FLUID LEVEL SENDERS

WASHER FLUID LEVEL SENDER INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Inoperative	A	(1) Require repair or replacement.
Leaking	A	Require repair or replacement.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(2) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.

Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.
Wire lead conductors exposed	B	Require repair or replacement.
Wire lead corroded	A	Require repair or replacement.
Wire lead open	A	Require repair or replacement.
Wire lead shorted	A	Require repair or replacement.

(1) - Inoperative includes intermittent operation or out of OEM specification.
(2) - Determine cause and correct prior to repair or replacement of part.

WASHER PUMPS

WASHER PUMP INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Connector broken	A	Require repair or replacement.
Connector melted	A	(1) Require repair or replacement.
Connector missing	C	Require replacement.
Inoperative	A	(2) Require repair or replacement.
Leaking externally	A	Require repair or replacement.
Leaking internally	A	Require repair or replacement.
Noisy	2	Suggest repair or replacement.
Resistance out of specification	B	Require repair or replacement.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(1) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.
Wire lead conductors exposed	B	Require repair or replacement.

Wire lead corroded	A	Require repair or replacement.
Wire lead open	A	Require repair or replacement.
Wire lead shorted	A	Require repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - Inoperative includes intermittent operation.

WIPER ARMS AND BLADES

NOTE: Windshield coatings or waxes can cause blades to not function as intended. Clean surface before making final judgment about blade replacement.

WIPER ARM AND BLADE INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Attaching socket stripped	A	Require replacement.
Bent	A	Require repair or replacement.
Loose	2	Suggest repair or replacement.
Missing	C	Require replacement.
Noisy	2	Suggest repair or replacement.
Size incorrect	2	Suggest replacement.
Tension insufficient	B	Require repair or replacement.
Torn	A	Require replacement.
Worn, affecting performance	A	Require replacement.
Worn, not affecting performance	1	Suggest replacement.

WIPER BLADES

See WIPER ARMS AND BLADES.

WIPER HOSES AND NOZZLES

WIPER HOSE AND NOZZLE INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Blocked	A	Require repair or replacement.

Leaking	A	Require repair or replacement.
Missing	C	Require replacement.
Oil-soaked (spongy)	1	Suggest replacement.
Spray pattern incorrect	2	Suggest repair or replacement.
Surface cracks (dry-rotted)	1	Suggest replacement.

WIPER LINKAGES

WIPER LINKAGE INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Attaching stud stripped	A	Require replacement.
Bent	A	Require repair or replacement.
Inoperative	A	(1) Require replacement.
Loose	2	Suggest repair or replacement.
Missing	C	Require replacement.
Noisy	2	Suggest repair or replacement.
Tension insufficient	B	Require repair or replacement.
Worn, affecting performance	A	Require replacement.
Worn, not affecting performance	1	Suggest replacement.

(1) - Inoperative includes intermittent operation.

WIPER NOZZLES

See WIPER HOSES AND NOZZLES.

WIPER PUMP RESERVOIRS

WIPER PUMP RESERVOIR INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Cap missing	C	Require replacement.
Leaking	A	Require repair or replacement.
Missing	C	Require replacement.

WIRING HARNESSES AND CONNECTORS

WIRING HARNESS AND CONNECTOR INSPECTION

Condition	Code	Procedure
Application incorrect	B	Require repair or replacement.
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Connector broken	A	Require repair or replacement.
Connector (Weatherpack type) leaking	A	Require repair or replacement.
Connector melted	A	(1) Require repair or replacement.
Connector missing	C	Require replacement.
Insulation damaged, conductors exposed	A	Require repair or replacement.
Insulation damaged, conductors not exposed	1	Suggest replacement.
Open	A	Require repair or replacement.
Protective shield (conduit) melted	2	(1) Suggest repair or replacement.
Protective shield (conduit) missing	2	Suggest repair or replacement.
Resistance (voltage drop) out of specification	A	Require repair or replacement.
Routed incorrectly	B	Require repair.
Secured incorrectly	B	Require repair.
Shorted	A	Require repair or replacement.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(1) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.
Voltage drop out of specification	A	Require repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.

GENERAL INFORMATION
Electrostatic Discharge (ESD) Warning - Basic Information

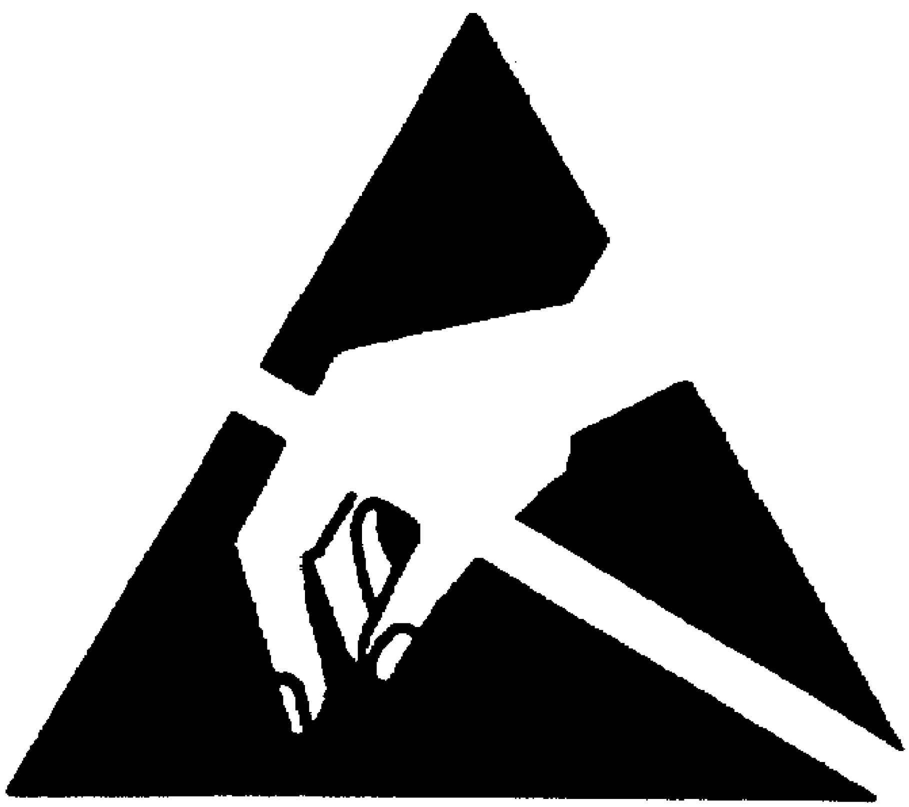
All Makes amd Models

* PLEASE READ THIS FIRST *

NOTE: This article is intended for general information purposes only.

INTRODUCTION

All Electrostatic Discharge (ESD) sensitive components contain solid state circuits (transistors, diodes, semiconductors) that may become damaged when contacted with an electrostatic charge. The following information applies to all ESD sensitive devices. The ESD symbol shown in Fig. 1 may be used on schematics to indicate which components are ESD sensitive. See Fig. 1. Although different manufactures may display different symbols to represent ESD sensitive devices, the handling and measuring precautions and procedures are the same.



50I12680

Fig. 1: Sample ESD Symbol

HANDLING STATIC-SENSITIVE CIRCUITS/DEVICES

When handling an electronic part that is ESD sensitive, the technician should follow these guidelines to reduce any possible electrostatic charge build-up on the technician's body and the electronic part.

1) Always touch a known good ground source before handling the part. This should be repeated while handling the part and more frequently after sitting down from a standing position, sliding across the seat or walking a distance.
2) Avoid touching electrical terminals of the part, unless instructed by a diagnostic procedure.
3) DO NOT open the package of a new part until it is time to install the part.
4) Before removing the part from its package, ground the package to a known good ground source.

CHECKING STATIC-SENSITIVE CIRCUITS/DEVICES

1) Solid State circuits in electronic devices are shown greatly simplified in schematics. See Fig. 2. Due to the simplification of the electronic devices on the schematic, resistance measurements could be misleading or could lead to an electrostatic discharge. Always follow the recommended diagnostic procedure.

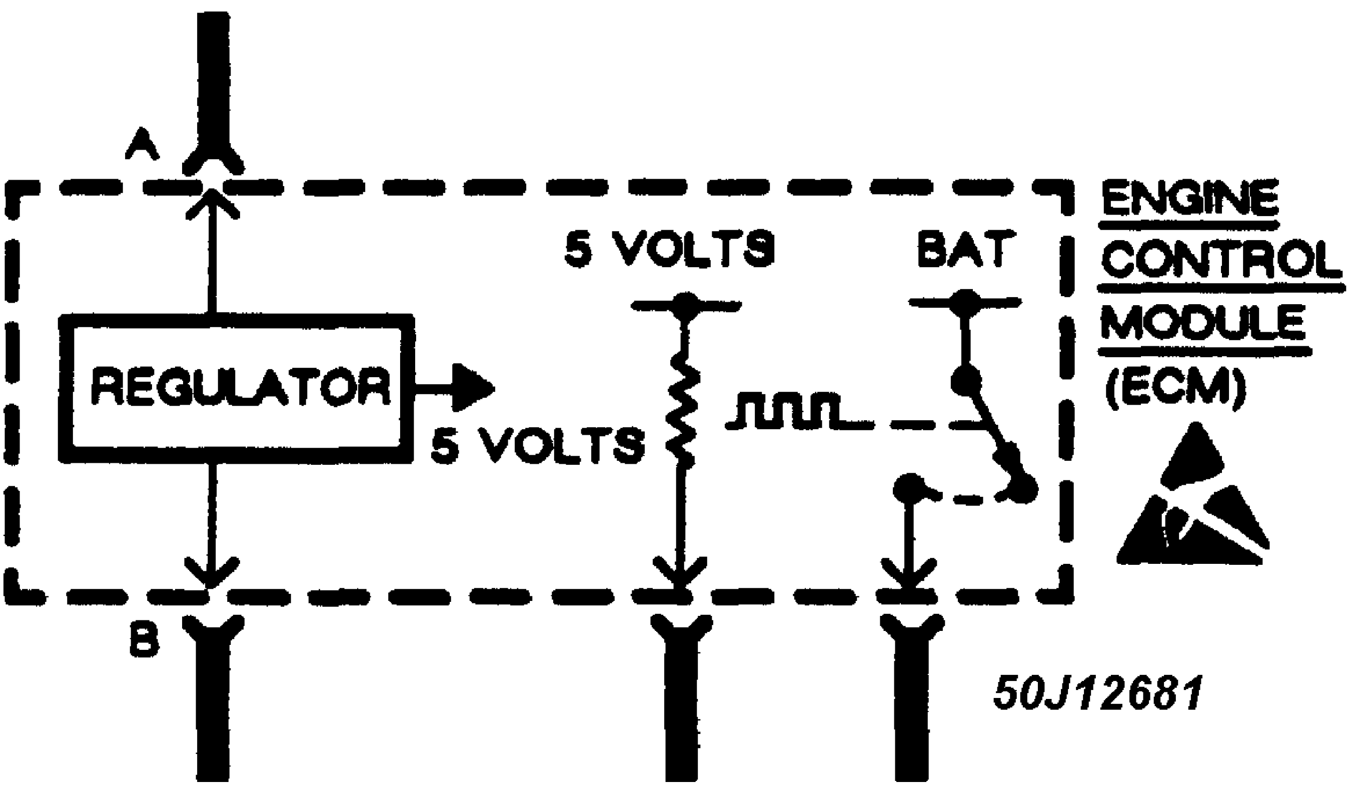


Fig. 2: Sample Schematic Showing Typical ESD Sensitive Device

2) Only measure resistance at the terminals of the devices when instructed by the recommended diagnostic procedure.
3) When using a voltmeter, be sure to connect the ground lead first.

EMISSION APPLICATION

1988 Jeep Cherokee

1988 ENGINE EMISSIONS
Jeep Emission Control Applications

Cherokee, Comanche, Grand Wagoneer, Pickup,
Wagoneer, Wrangler

EMISSION CONTROL DEVICE APPLICATIONS

EMISSION CONTROL DEVICE APPLICATIONS TABLE

2.5L (150") 4-Cyl. TBI
PCV, EVAP, OC (3), EGR, SPK, CEC, O2

4.0L (242") 6-Cyl. MPFI
PCV, EVAP, AIS (2), DBC, EGR, SPK, CEC, O2, ACV, ASV

4.2L (258") 6-Cyl. 2-Bbl.
PCV, TAC, AIS, EVAP, DBC, EGR, SPK, CEC, O2, ACV, ASV, EFE, EGR-CTO, EGR-TVS, MCU, SLV, VSA (1)

5.9L (360") V8 2-Bbl.
PCV, TAC, AIS, EVAP, DBC, EGR, SPK, ACV, DLV, EGR-CTO, EGR-TVS, MCU (2), NLV, RDV, VA-CTO (2) (3), VSA (2)

(1) - Some Fed., all Calif.
(2) - Calif. only.
(3) - TWC on Calif.

ABBREVIATION DEFINITIONS

ABBREVIATIONS DEFINITIONS TABLE

Abbreviation	Description
ACV	Air Control Valve
AIS	Air Injection System
ASV	Air Switching Valve
CEC	Computerized Engine Control
DC-VLV	Deceleration Valve
DLV	Delay Valve
DVTRV	Diverter Valve
EGR	Exhaust Gas Recirculation
EGR-CTO	EGR Coolant Temperature Override
EGR-FDLV	EGR Foward Delay Valve
EGR-TVS	EGR Thermal Vacuum Switch
EST	Electronic Spark Control
EVAP	Evap. Emission Control
HDSP-CT	Heavy Duty Spark Coolant Temp. Override
HDVA-CTO	Heavy Duty Vac. Advance Coolant Temp. Override
MCU	Micro Computer Unit
MPS	Manifold Pressure Sensor
NLRV	Non-Linear Vacuum Regulator
OC	Oxidation Catalyst
O2	Oxygen Sensor
PCV	Positive Crankcase Ventilation
RDV	Reverse Delay Valve
S-CTO	Spark Coolant Temp. Override
SLV	Solevac

SPK	Spark
TAC	Thermostatic Air Cleaner
TPS	Throttle Position Sensor
TSD	Throttle Solenoid
TP	Throttle Positioner
TWC	Three-Way Catalyst
VA-CTO	Vacuum Advance Coolant Temp. Override
VSA	Vacuum Switch Assembly
VTP	Vacuum Throttle Positioner

EMISSION COMPONENT IDENTIFICATION

1988 Jeep Cherokee

1988 Exhaust Emission Systems
JEEP SYSTEMS

NOTE: Information not available from manufacturer for Jeep 2.5L TBI and 4.0L MPFI emission systems.

DESCRIPTION

Several systems are used to control emissions. System usage depends on model, engine and transmission combinations. Each system is designed to control vehicle emissions. In addition, specially calibrated carburetors (carbureted models), fuel injection system, distributors and modified combustion chambers are used with these systems.

AIR INJECTION

Air injection system consists of air pump, diverter valve, check valve, and various air distribution lines necessary to inject fresh air adjacent to exhaust valves. Injection of fresh air adjacent to exhaust valves creates an afterburn which further consumes unburned gases in engine’s exhaust.

CATALYTIC CONVERTER (CAT)

Converter is installed in vehicle’s exhaust system to aid in reduction of exhaust emissions. This unit changes unburned hydrocarbons (HC) and carbon monoxide (CO) into water vapor and carbon dioxide.

COMPUTERIZED EMISSION CONTROL (CEC) SYSTEM

CEC system closely controls air/fuel ratio through a feedback system from an oxygen sensor in exhaust system. Major components of this system include exhaust gas oxygen sensor, vacuum switches, temperature switches, Micro Computer Unit (MCU), fuel injection system or computer controlled carburetor (carbureted models) to maintain a constant air/fuel mixture. For additional information, see appropriate article in COMPUTERIZED ENGINE CONTROL section.

EVAPORATIVE EMISSION CONTROL

All models use closed tank (sealed) system, which returns raw fuel vapors and routes them to intake manifold for burning. Carbon canister stores vapors until engine draws them off for burning.

OTHER EMISSION SYSTEMS

For additional information on description, operation, testing and adjusting other exhaust emission systems, refer to the following articles in this section.

EMISSION CONTROL VISUAL INSPECTION PROCEDURES

1988 Jeep Cherokee

1983-98 GENERAL INFORMATION
Emission Control Visual Inspection Procedures

All Models

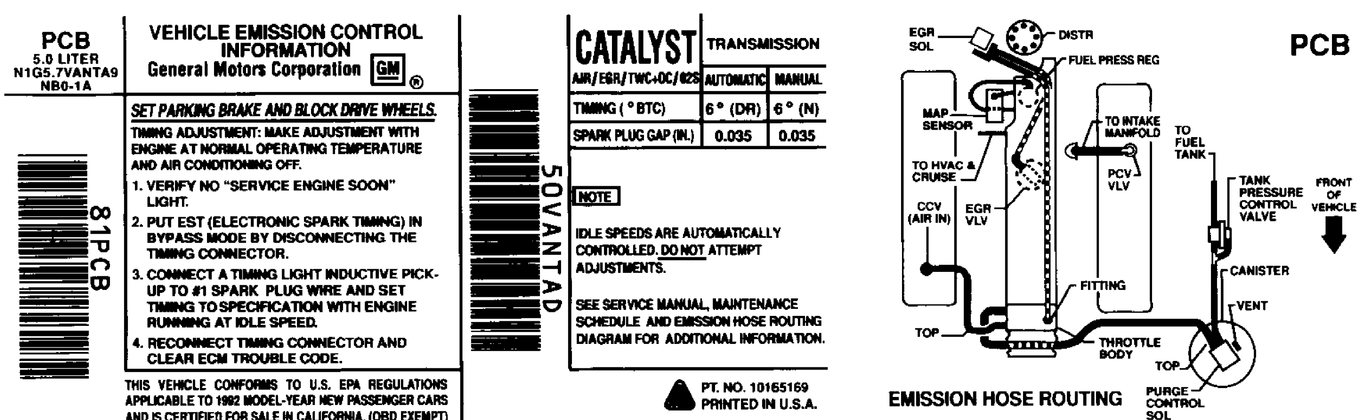
* PLEASE READ THIS FIRST *

This article is provided for general information only. Not all information applies to all makes and models. For more complete information, see appropriate article(s) in the ENGINE PERFORMANCE Section.

EMISSION CONTROL LABELS

The vehicle manufacturer's emission control label, also known as the underhood tune-up label or Vehicle's Underhood Emission Control System (VECI) label, is located in the engine compartment. Information regarding year model of vehicle, engine size, number of cylinders, emission equipment or type, engine tune-up specifications, whether vehicle was manufactured for sale in California or is a Federal vehicle, vacuum hose routing schematic, etc., can be found on this label. See Fig. 1.

In addition to the VECI label, some emission control inspection and maintenance programs may require an additional label to be affixed to the vehicle in special circumstances. For example, in California, a Bureau Of Automotive Repair (BAR) engine label may be affixed to the left door post. A BAR engine label is only used when the vehicle has an engine change, approved modification or is a Specially Constructed (SPCN) or an acceptable Gray market vehicle. Check your state's emission control inspection and maintenance laws to determine if a similar label is used.



93D04127
Fig. 1: Typical Emission Control Label
Courtesy of General Motors Corp.

EMISSION CONTROL VISUAL INSPECTION

* PLEASE READ THIS FIRST *

NOTE: The following emission control visual inspection procedures should be used as a guide only. When performing a visual inspection, always follow your state's recommended

inspection procedures.

A visual inspection is made to determine if any required emission control devices are missing, modified or disconnected. Missing, modified or disconnected systems must be made fully operational before a vehicle can be certified.

POSITIVE CRANKCASE VENTILATION (PCV)

PCV controls the flow of crankcase fumes into the intake manifold while preventing gases and flames from traveling in the opposite direction. PCV is either an open or closed system. See Fig. 2 .

Ensure PCV system is installed as required. Verify valve, required hoses, connections, flame arresters, etc., are present, routed properly and in serviceable condition.

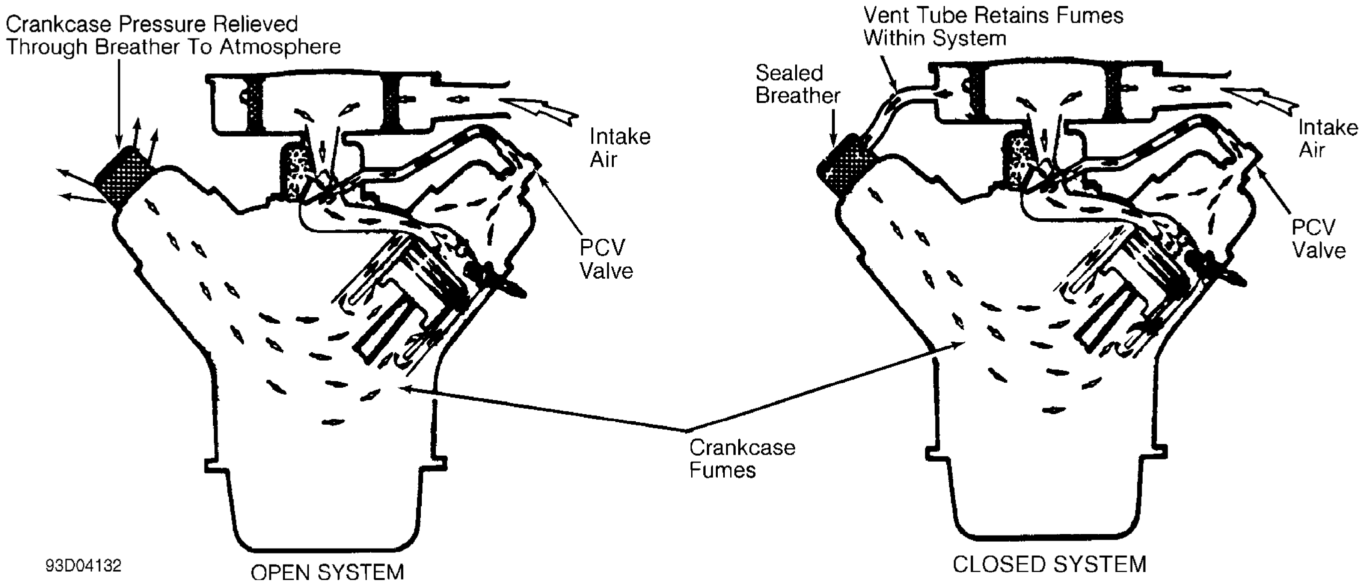


Fig. 2: Typical Open & Closed Type PCV System

THERMOSTATIC AIR CLEANER (TAC)

The TAC supplies warm air to air intake during cold engine operation. This system is active during cold engine warm-up only. Under all other operating conditions, air cleaner function is the same as any non-thermostatic unit.

Ensure required exhaust shroud, hot air duct, vacuum hoses and air cleaner components are present and installed properly. See Fig. 3. Ensure any required thermostatic vacuum switches are in place and vacuum hoses are installed and in serviceable condition. Also ensure air cleaner lid is installed right side up. Check for oversized air filter elements and for additional holes in the air cleaner housing.

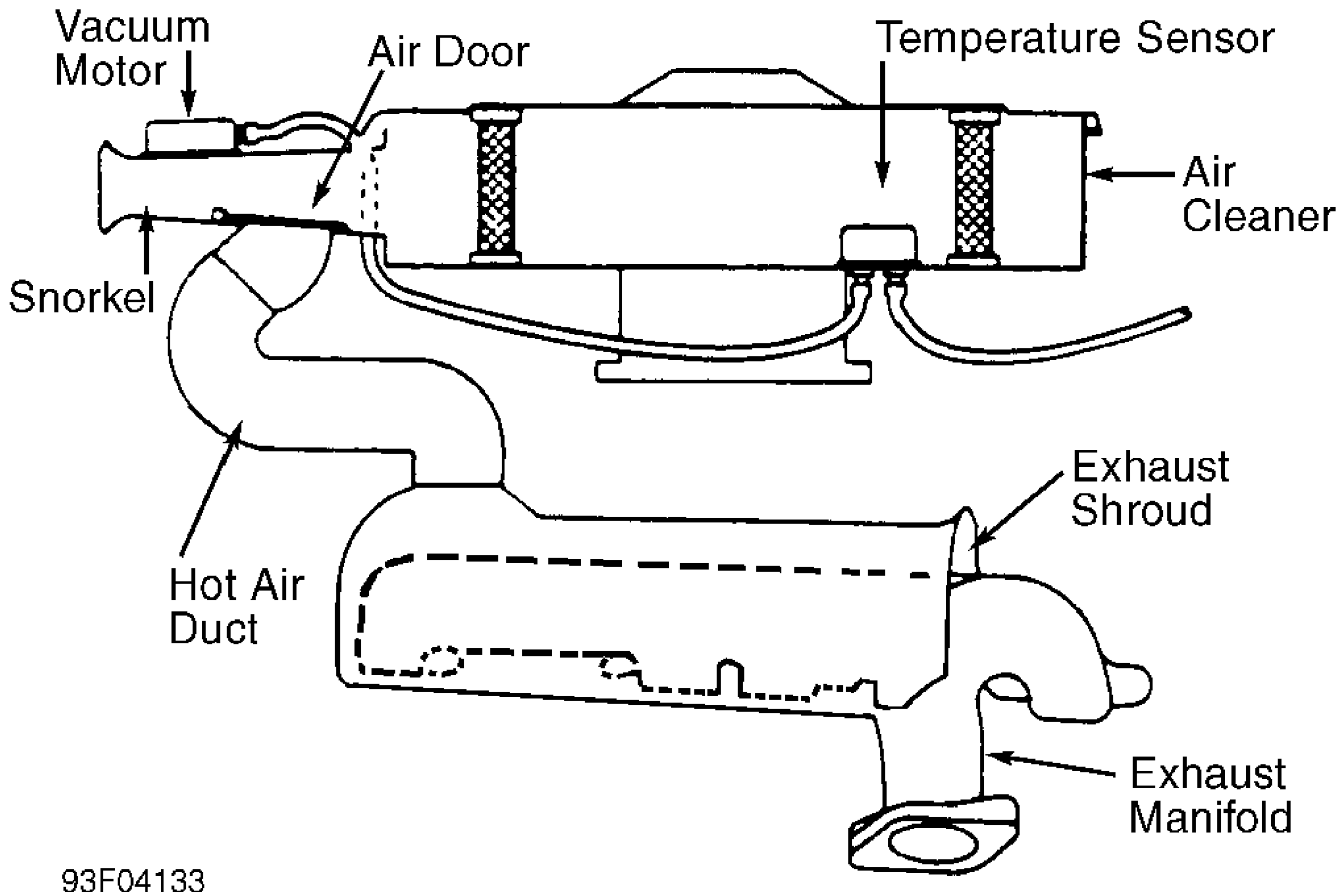


Fig. 3: Typical Thermostatic Air Cleaner System

FUEL EVAPORATIVE SYSTEM (EVAP)

The EVAP system allows for proper fuel system ventilation while preventing fuel vapors from reaching the atmosphere. This means that vapors must be caught and stored while the engine is off, which is when most fuel evaporation occurs. When the engine is started, these fuel vapors can be removed from storage and burned. In most systems, storage is provided by an activated charcoal (or carbon) canister. See Fig. 4. On a few early systems, charcoal canisters are not used. Instead, fuel vapors are vented into the PCV system and stored inside the crankcase.

The main components of a fuel evaporation system are a sealed fuel tank, a liquid-vapor separator and vent lines to a vapor-storing canister filled with activated charcoal. The filler cap is normally not vented to the atmosphere, but is fitted with a valve to allow both pressure and vacuum relief.

Although a few variations do exist between manufacturers, basic operation is the same for all systems. Check for presence of vapor storage canister or crankcase storage connections when required. Ensure required hoses, solenoids, etc., are present and connected properly. Check for proper type fuel tank cap. Check for any non-OEM or auxiliary fuel tanks for compliance and the required number of evaporation canisters.

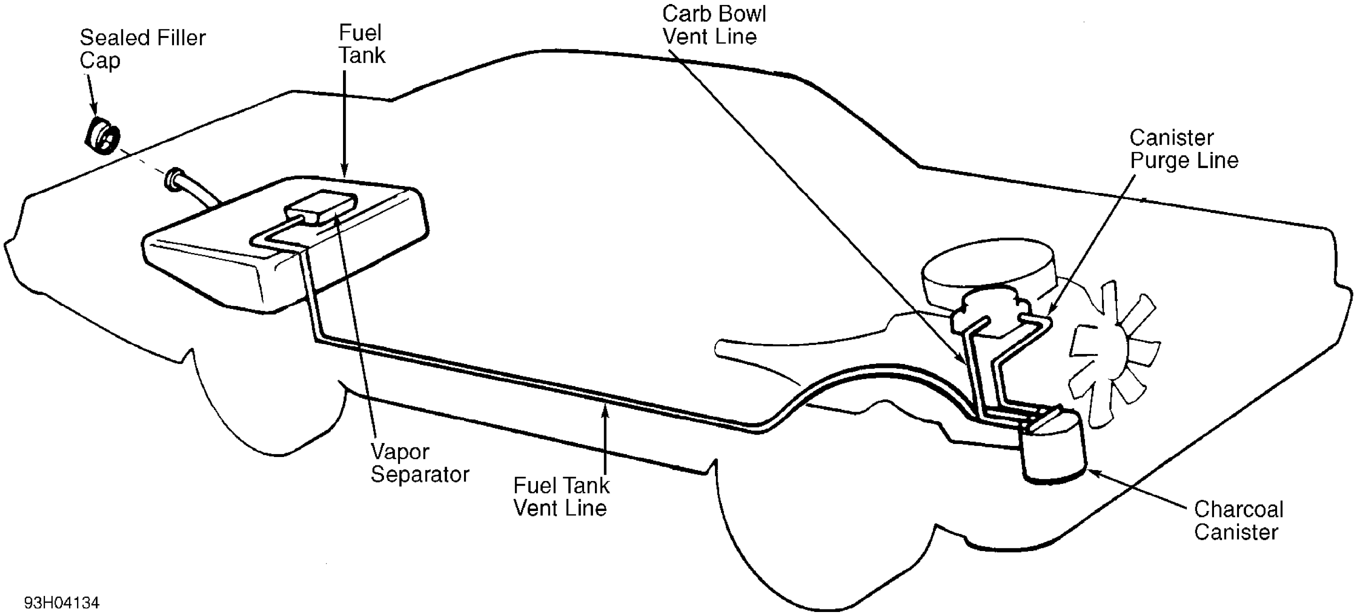


Fig. 4: Typical Fuel Evaporative System

CATALYTIC CONVERTERS

Oxidation Catalyst (OC)

This type of converter is the most common. It may use pellets or monolith medium, depending upon application. See Fig. 5. Platinum and palladium (or platinum alone) are used as catalyst in this type of converter.

Visually check for presence of catalytic converter(s). Check for external damage such as severe dents, removed or damaged heat shields, etc. Also check for pellets or pieces of converter in the tailpipe.

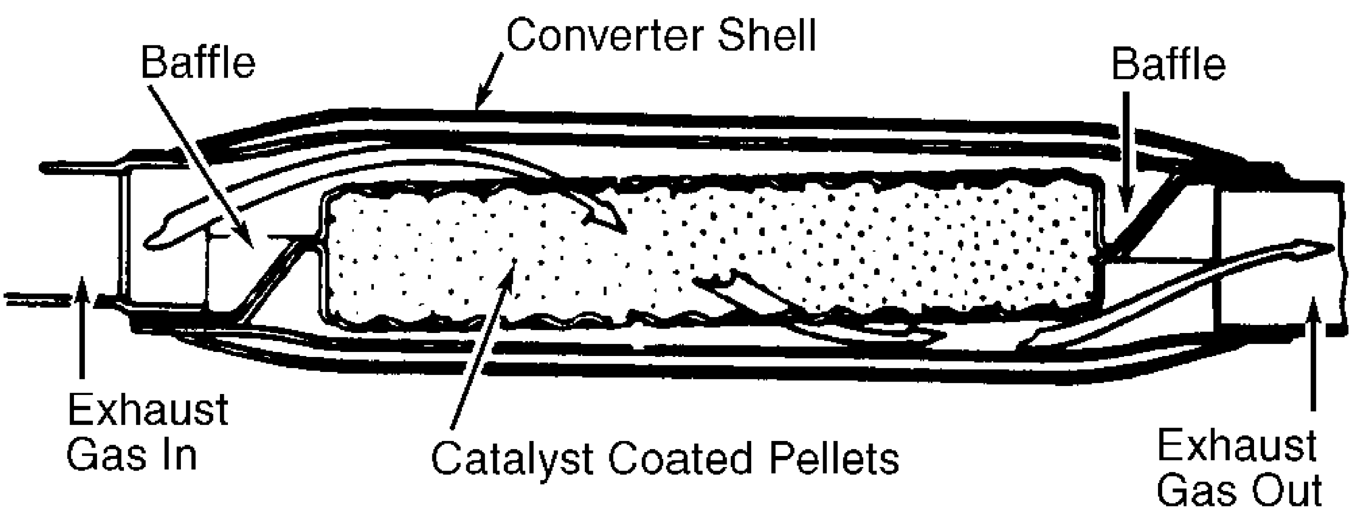


Fig. 5: Typical Oxidation Catalytic Converter (Pellet Type) Shown; Typical Three-Way Catalytic Converter Is Similar
Courtesy of General Motors Corp.

Three-Way Catalyst (TWC)

This type of converter is nearly identical to a conventional

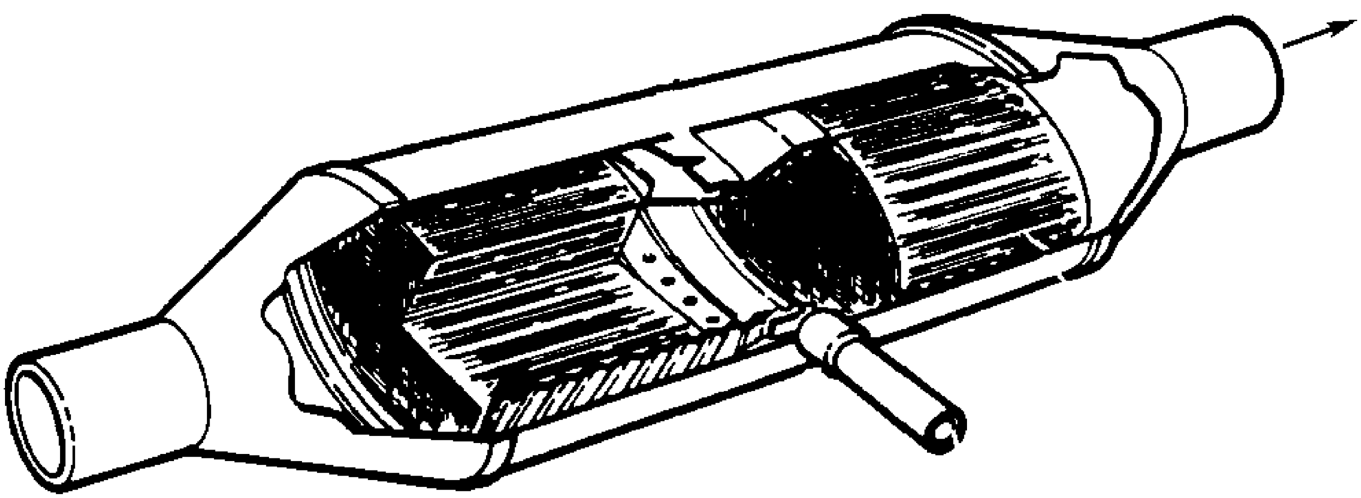
converter with the exception of the catalyst. See Fig. 5. The TWC converter uses rhodium, with or without platinum, as its catalyst. Rhodium helps reduce NOx emissions, as well as HC and CO.

Visually check for presence of catalytic converter(s). Also check for presence of any required air supply system for the oxidizing section of the converter. Check for external damage such as severe dents, removed or damaged heat shields, etc. Check for pellets or pieces of converter in the tailpipe.

Three-Way Catalyst + Oxidation Catalyst (TWC + OC)

This system contains a TWC converter and an OC converter in a common housing, separated by a small air space. See Fig. 6. The 2 catalysts are referred to as catalyst beds. Exhaust gases pass through the TWC first. The TWC bed performs the same function as it would as a separate device, reducing all 3 emissions. As exhaust gases leave the bed, they pass through the air space and into the second (OC) converter catalyst bed.

Visually check for presence of catalytic converter(s). Check for external damage such as severe dents, removed or damaged heat shields, etc. Check for pellets or pieces of converter in the tailpipe.



93C04136

Fig. 6: Typical Three-Way + Oxidation Catalytic Converter
Courtesy of General Motors Corp.

FILL PIPE RESTRICTOR (FR)

A fuel tank fill pipe restrictor is used to prohibit the introduction of leaded fuel into the fuel tank. Unleaded gasoline pump dispensers have a smaller diameter nozzle to fit fuel tank of vehicle requiring the use of unleaded fuel (vehicles equipped with catalytic converter).

Visually inspect fill pipe restrictor(s) for tampering, i.e., restrictor is oversize or the flapper is non-functional. If vehicle is equipped with an auxiliary fuel tank, ensure auxiliary fuel tank is also equipped with a fill pipe restrictor.

EXHAUST GAS RECIRCULATION (EGR) SYSTEM

Single Diaphragm EGR Valve

This type uses a single diaphragm connected to the valve by a shaft. Diaphragm is spring-loaded to keep valve closed in the absence of vacuum. As throttle valves open and engine speed increases, vacuum is applied to the EGR vacuum diaphragm, opening the EGR valve. This vacuum signal comes from a ported vacuum source. Variations in the vacuum signal control the amount of exhaust gas that is recirculated. See Fig. 7.

Verify EGR valve is present and not modified or purposely damaged. Ensure thermal vacuum switches, pressure transducers, speed switches, etc., (if applicable) are not by-passed or modified. Ensure vacuum hose(s) to EGR valve is not plugged.

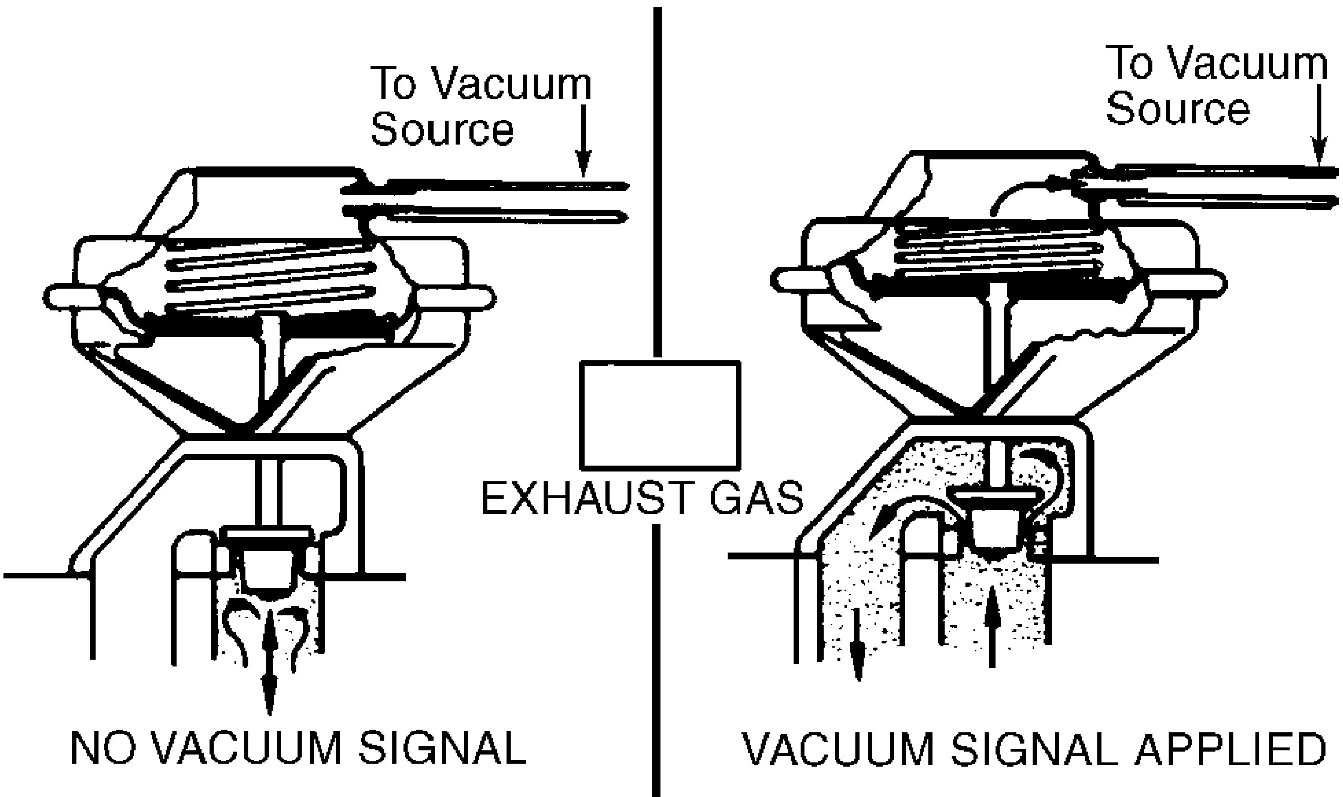


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Fig. 7: Typical Single Diaphragm EGR Valve
Courtesy of General Motors Corp.

Dual Diaphragm EGR Valve

This type uses 2 diaphragms with different effective areas and 2 vacuum sources. Although similar to the single diaphragm type, the second diaphragm is added below the upper diaphragm and is rigidly attached to the valve seat. See Fig. 8. These diaphragms form a vacuum chamber which is connected to manifold vacuum.

During highway cruising when manifold vacuum is high in the center chamber, manifold vacuum tends to pull the valve closed. However, the vacuum signal applied to the top side of the upper diaphragm overcomes the downward spring force and the manifold vacuum pull, due to the diaphragm's larger piston. This regulates the amount of EGR.

When manifold vacuum is low during acceleration, the higher vacuum signal opens the valve, permitting more EGR. When manifold vacuum is high during highway cruising, the valve is only partially opened, reducing the amount of EGR.

Verify EGR valve is present and not modified or purposely damaged. Ensure thermal vacuum switches, pressure transducers, speed switches, etc., (if applicable) are not by-passed or modified. Ensure vacuum hose(s) to EGR valve is not plugged.

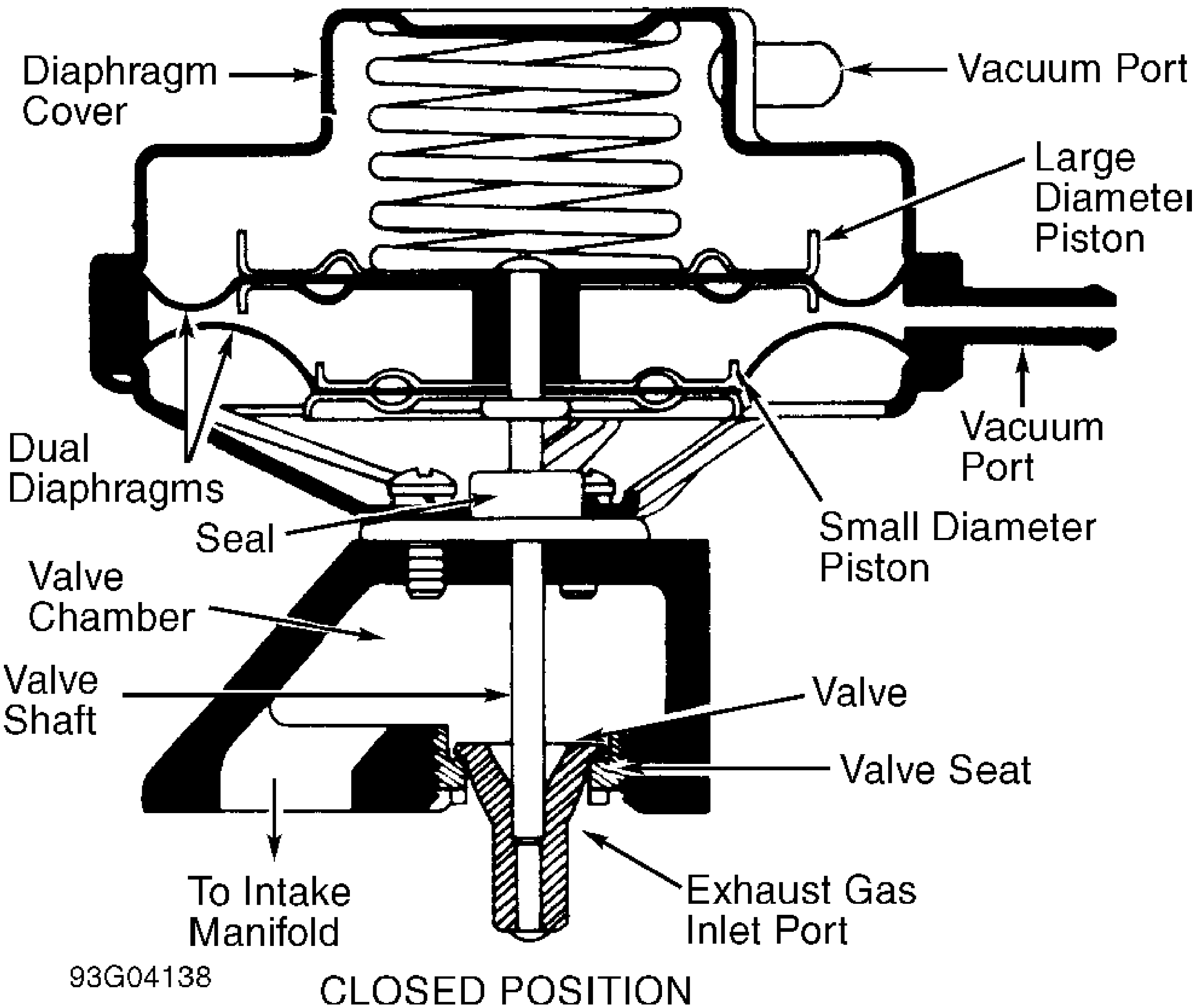

Fig. 8: Typical Dual Diaphragm EGR Valve
Courtesy of General Motors Corp.

Positive Backpressure EGR (BP/EGR) Valve

This type uses both engine vacuum and exhaust backpressure to control the amount of EGR. It provides more recirculation during heavy engine loads than the single diaphragm EGR valve.

A small diaphragm-controlled valve inside EGR valve acts as a pressure regulator. The control valve gets an exhaust backpressure signal through the hollow valve shaft. This exhaust backpressure exerts a force on bottom of control valve diaphragm. The diaphragm plate contains 6 bleed holes to bleed air into the vacuum chamber when backpressure valve is in open position. See Fig. 9.

Verify EGR valve is present and not modified or purposely damaged. Ensure thermal vacuum switches, pressure transducers, speed

switches, etc., (if applicable) are not by-passed or modified. Ensure vacuum hose(s) to EGR valve is not plugged.

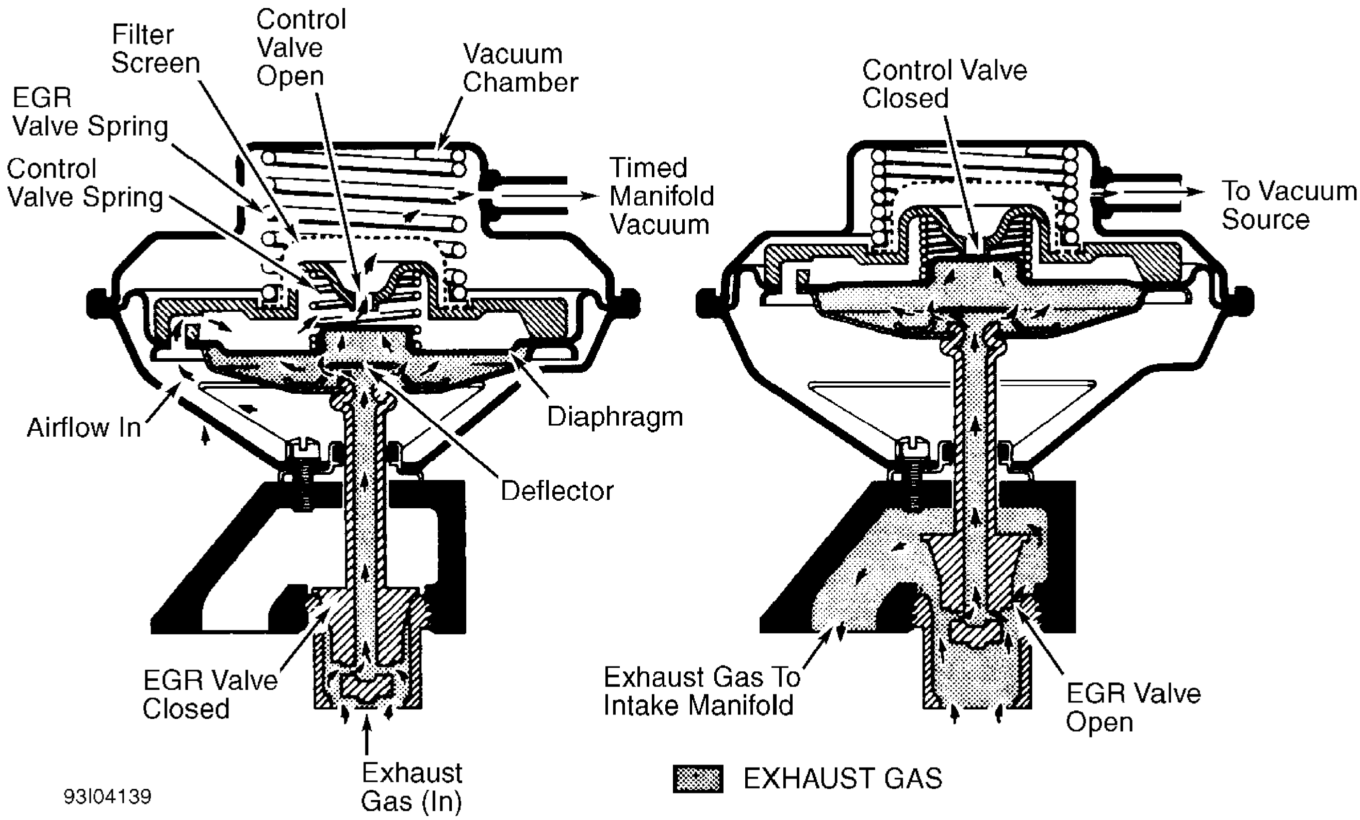

Fig. 9: Typical Positive Backpressure EGR Valve
Courtesy of General Motors Corp.

Negative Backpressure EGR (BP/EGR) Valve

This type has the same function as the positive BP/EGR valve except valve is designed to open with a negative exhaust backpressure. The control valve spring in the transducer is placed on the bottom side of the diaphragm. See Fig. 10.

When ported vacuum is applied to the main vacuum chamber, partially opening the valve, the vacuum signal from the manifold side (reduced by exhaust backpressure) is transmitted to the hollow stem of the valve. See Fig. 10. This enables the signal to act on the diaphragm, providing a specific flow. Thus, the EGR flow is a constant percentage of engine airflow.

Verify EGR valve is present and not modified or purposely damaged. Ensure thermal vacuum switches, pressure transducers, speed switches, etc., (if applicable) are not by-passed or modified. Ensure vacuum hose(s) to EGR valve is not plugged.

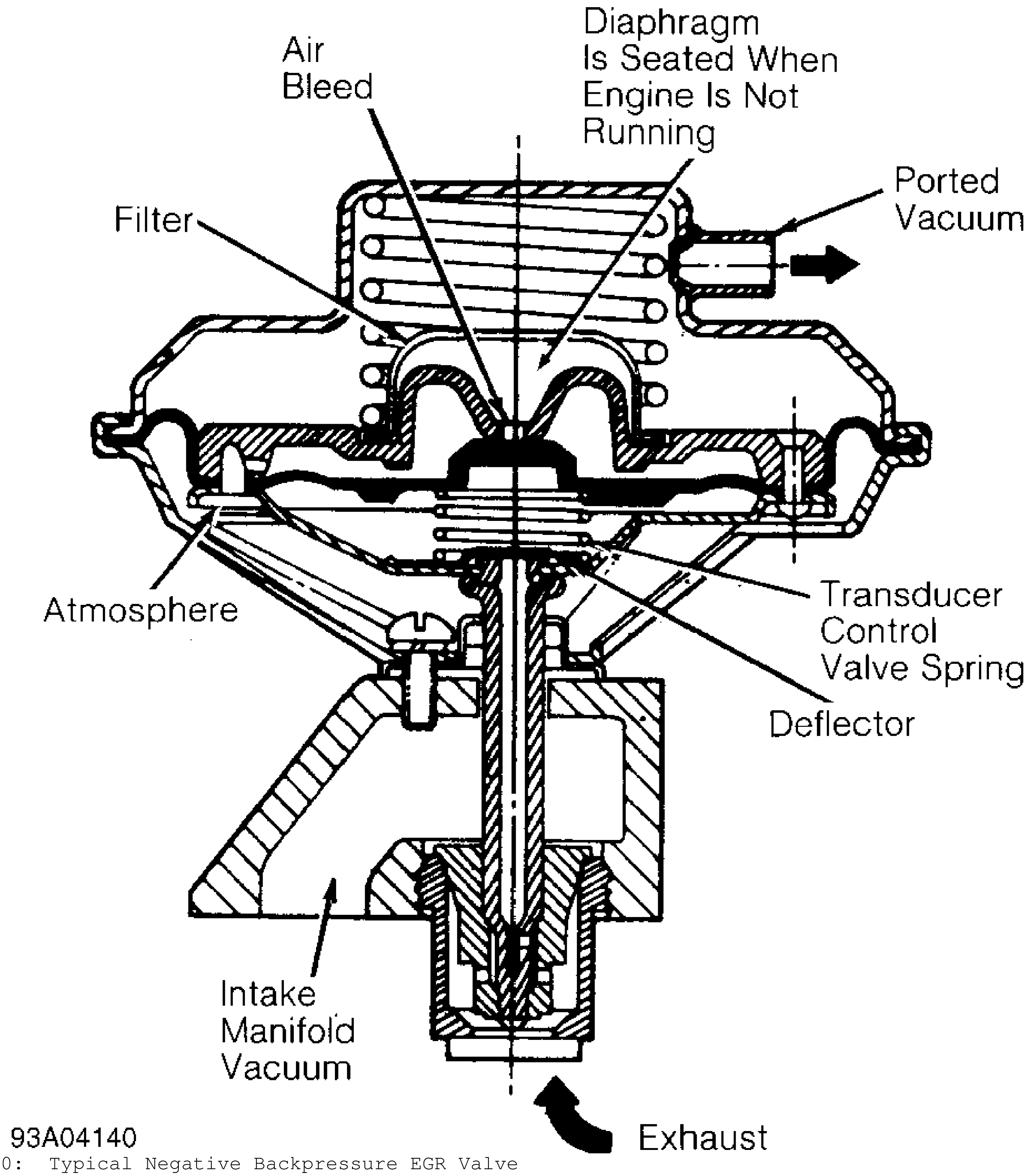

Fig. 10: Typical Negative Backpressure EGR Valve
Courtesy of General Motors Corp.

Digital EGR Valve

The digital EGR valve operates independently of engine manifold vacuum. This valve controls EGR flow through 3 orifices.

These 3 orifices are opened and closed by electric solenoids. The solenoids are, in turn, controlled by the Electronic Control Module (ECM). When a solenoid is energized, the armature with attached shaft and swivel pintle is lifted, opening the orifice. See Fig. 11.

The ECM uses inputs from the Coolant Temperature Sensor (CTS), Throttle Position Sensor (TPS) and Mass Airflow (MAF) sensors to control the EGR orifices to make 7 different combinations for precise EGR flow control. At idle, the EGR valve allows a very small amount of exhaust gas to enter the intake manifold. This EGR valve normally operates above idle speed during warm engine operation.

Verify EGR valve is present and not modified or purposely damaged. Ensure thermal vacuum switches, pressure transducers, speed switches, etc., (if applicable) are not by-passed or modified. Ensure vacuum hose(s) to EGR valve is not plugged. Ensure electrical connector to EGR valve is not disconnected.

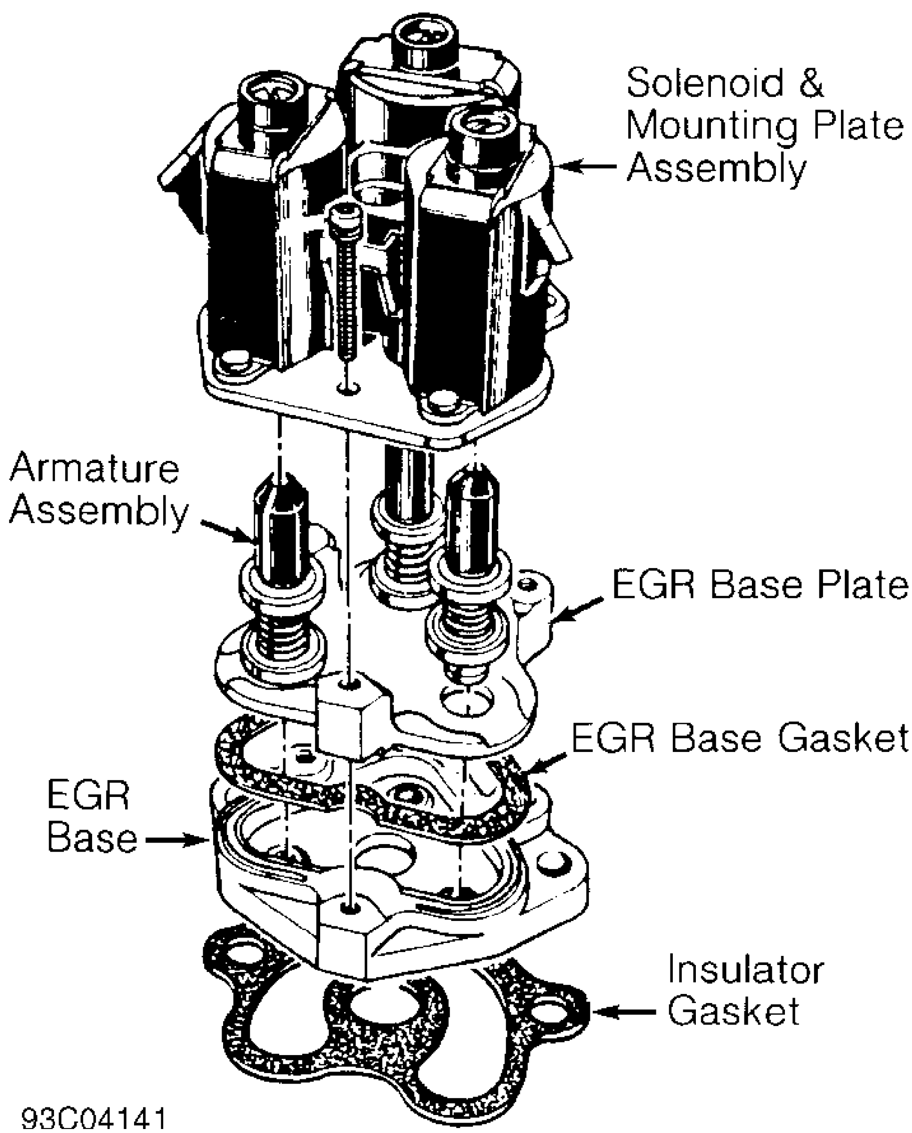

Fig. 11: Typical Digital EGR Valve
Courtesy of General Motors Corp.

Integrated Electronic EGR Valve

This type functions similar to a ported EGR valve with a

remote vacuum regulator. The internal solenoid is normally open, which causes the vacuum signal to be vented off to the atmosphere when EGR is not controlled by the Electronic Control Module (ECM). The solenoid valve opens and closes the vacuum signal, controlling the amount of vacuum applied to the diaphragm. See Fig. 12.

The electronic EGR valve contains a voltage regulator, which converts ECM signal and regulates current to the solenoid. The ECM controls EGR flow with a pulse width modulated signal based on airflow, TPS and RPM. This system also contains a pintle position sensor, which works similarly to a TPS sensor. As EGR flow is increased, the sensor output increases.

Verify EGR valve is present and not modified or purposely damaged. Ensure thermal vacuum switches, pressure transducers, speed switches, etc., (if applicable) are not by-passed or modified. Ensure electrical connector to EGR valve is not disconnected.

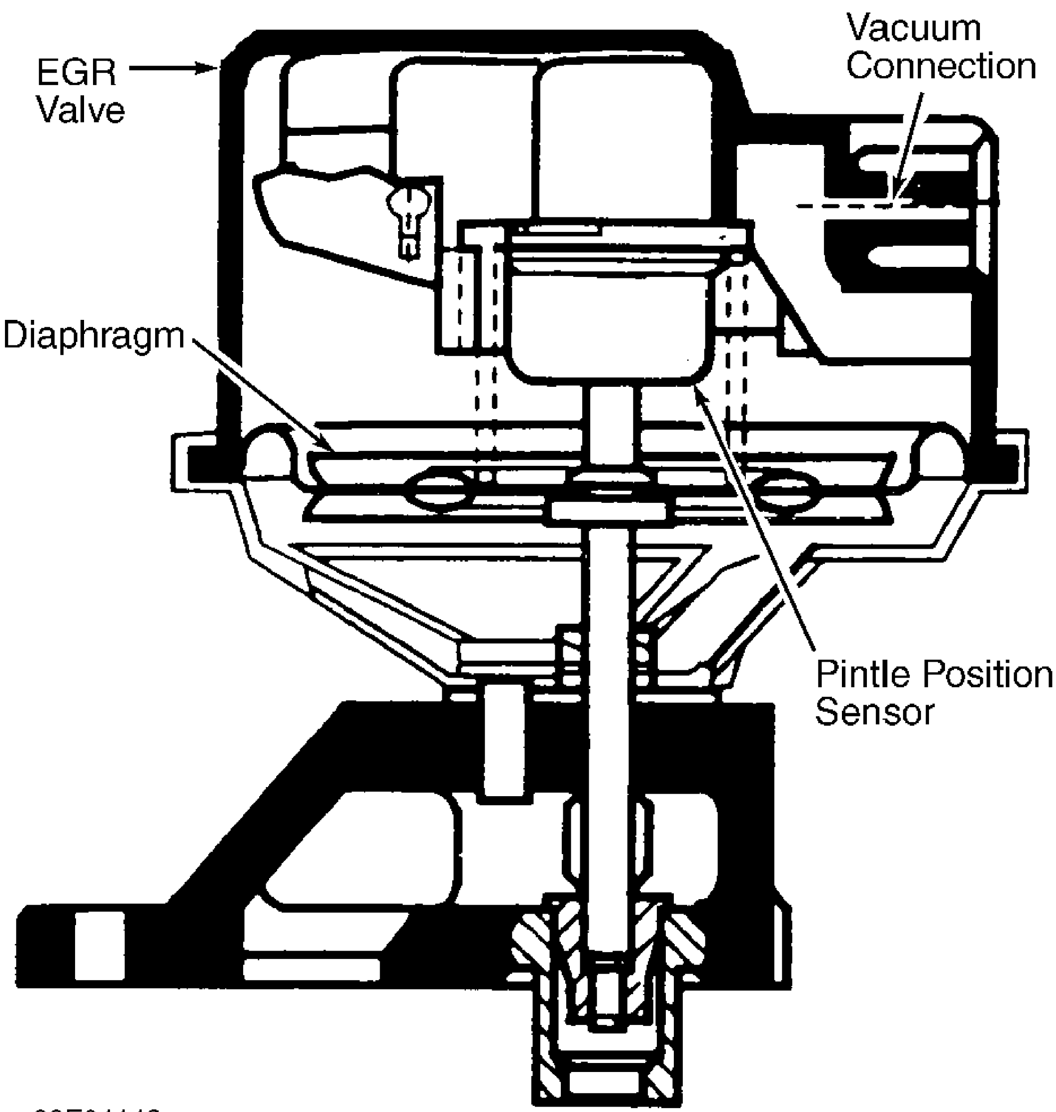

Fig. 12: Cutaway View Of Typical Integrated Electronic EGR Valve
Courtesy of General Motors Corp.

SPARK CONTROLS (SPK)

Spark control systems are designed to ensure the air/fuel mixture is ignited at the best possible moment to provide optimum efficiency and power and cleaner emissions.

Ensure vacuum hoses to the distributor, carburetor, spark delay valves, thermal vacuum switches, etc., are in place and routed properly. On Computerized Engine Controls (CEC), check for presence of required sensors (O2, MAP, CTS, TPS, etc.). Ensure they have not been tampered with or modified.

Check for visible modification or replacement of the feedback carburetor, fuel injection unit or injector(s) with a non-feedback carburetor or fuel injection system. Check for modified emission-related components unacceptable for use on pollution-controlled vehicles.

AIR INJECTION SYSTEM (AIS)

Air Pump Injection System (AP)

The air pump is a belt-driven vane type pump, mounted to engine in combination with other accessories. The air pump itself consists of the pump housing, an inner air cavity, a rotor and a vane assembly. As the vanes turn in the housing, filtered air is drawn in through the intake port and pushed out through the exhaust port. See Fig. 13.

Check for missing or disconnected belt, check valve(s), diverter valve(s), air distribution manifolds, etc. Check air injection system for proper hose routing.

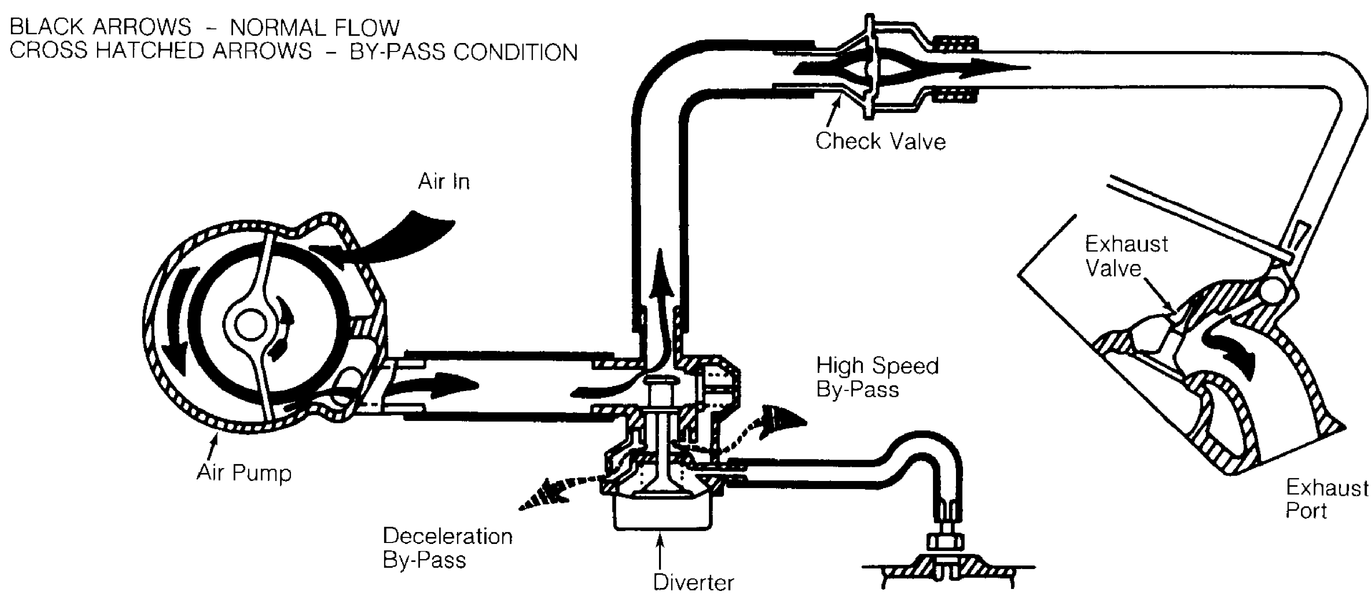

Fig. 13: Typical Air Pump Injection System
Courtesy of General Motors Corp.

Pulsed Secondary Air Injection (PAIR) System

PAIR eliminates the need for an air pump and most of the associated hardware. Most systems consists of air delivery pipe(s), pulse valve(s) and check valve(s). The check valve prevents exhaust gases from entering the air injection system. See Fig. 14.

Ensure required check valve(s), diverter valve(s), air distribution manifolds, etc., are present. Check air injection system for proper hose routing.

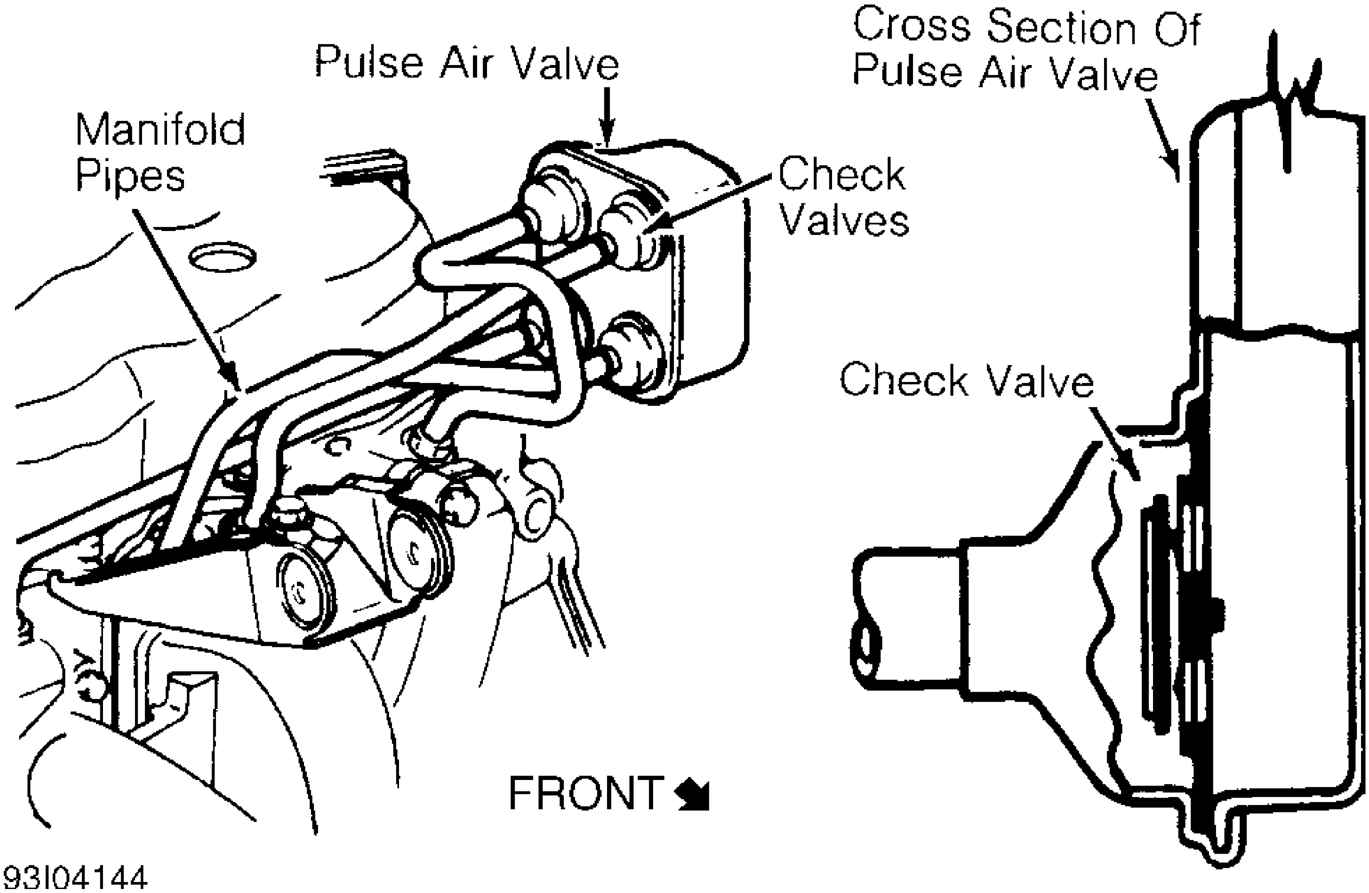

Fig. 14: Typical Pulsed Secondary Air Injection System
Courtesy of General Motors Corp.

OXYGEN SENSOR (O2)

The O2 sensor is mounted in the exhaust system where it monitors oxygen content of exhaust gases. Some vehicles may use 2 O2 sensors. The O2 sensor produces a voltage signal which is proportional to exhaust gas oxygen concentration (0-3%) compared to outside oxygen (20-21%). This voltage signal is low (about .1 volt) when a lean mixture is present and high (1.0 volt) when a rich mixture is present.

As ECM compensates for a lean or rich condition, this voltage signal constantly fluctuates between high and low, crossing a reference voltage supplied by the ECM on the O2 signal line. This is referred to as cross counts. A problem in the O2 sensor circuit should set a related trouble code.

COMPUTERIZED ENGINE CONTROLS (CEC)

The CEC system monitors and controls a variety of engine/vehicle functions. The CEC system is primarily an emission control system designed to maintain a 14.7:1 air/fuel ratio under most operating conditions. When the ideal air/fuel ratio is maintained, the catalytic converter can control oxides of nitrogen (NOx), hydrocarbon (HC) and carbon monoxide (CO) emissions.

The CEC system consists of the following sub-systems: Electronic Control Module (ECM), input devices (sensors and switches) and output signals.

EARLY FUEL EVAPORATION (EFE)

The EFE valve is actuated by either a vacuum actuator or a bimetal spring (heat-riser type). The EFE valve is closed when engine is cold. The closed valve restricts exhaust gas flow from the exhaust manifold. This forces part of the exhaust gas to flow up through a passage below the carburetor. As the exhaust gas quickly warms the intake mixture, distribution is improved. This results in better cold engine driveability, shorter choke periods and lower emissions.

Ensure EFE valve in exhaust manifold is not frozen or rusted in a fixed position. On vacuum-actuated EFE system, check EFE thermal vacuum valve and check valve(s). Also check for proper vacuum hose routing. See Fig. 15.

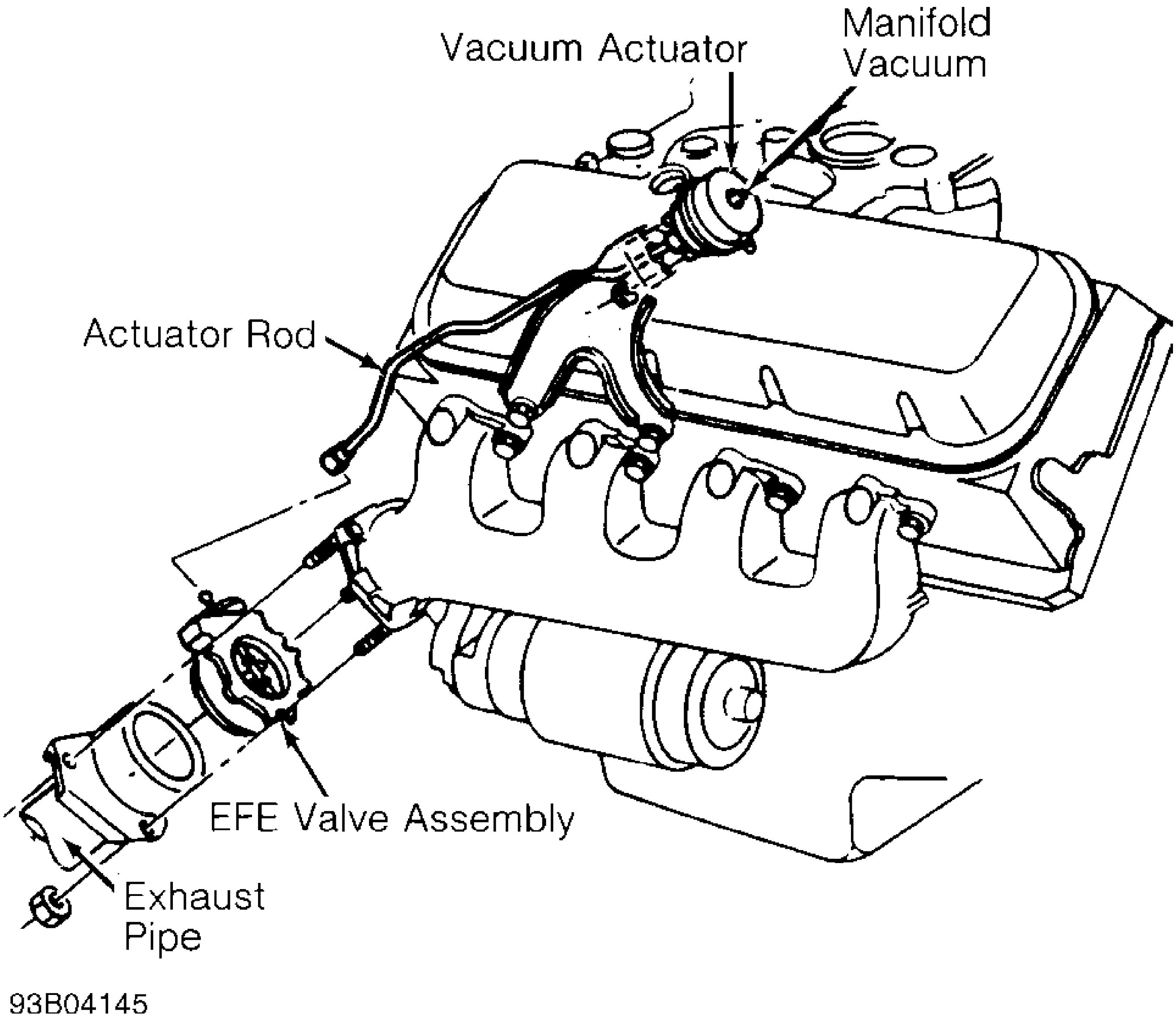

Fig. 15: Typical Vacuum-Actuated EFE System
Courtesy of General Motors Corp.

EMISSION MAINTENANCE REMINDER LIGHT (EMR) (IF EQUIPPED)

If equipped, the EMR light (some models may use a reminder flag) reminds vehicle operator that an emission system maintenance is required. This indicator is activated after a predetermined time/mileage.

When performing a smog check inspection, ensure EMR indicator is not activated. On models using an EMR light, light should glow when ignition switch is turned to ON position and should turn off when engine is running.

If an EMR flag is present or an EMR light stays on with engine running, fail vehicle and service or replace applicable emission-related components. To reset an EMR indicator, refer to appropriate MAINTENANCE REMINDER LIGHTS in the MAINTENANCE section.

MALFUNCTION INDICATOR LIGHT (MIL)

The Malfunction Indicator Light (MIL) is used to alert vehicle operator that the computerized engine control system has detected a malfunction (when it stays on all the time with engine running). On some models, the MIL may also be used to display trouble codes.

As a bulb and system check, malfunction indicator light will glow when ignition switch is turned to ON position and engine is not running. When engine is started, light should go out.

EMISSIONS RECALL #617 - OXYGEN SENSOR & CAT. CONV.

1988 Jeep Cherokee

EMISSION RECALL BULLETIN

EMISSIONS RECALL #617 - OXYGEN SENSOR AND CATALYTIC CONVERTER

Model(s): 1989 and 1990 Jeep Cherokee (XJ), Comanche (MJ) and Wrangler (YJ) Vehicles Equipped With a 2.5L Engine and a Federal Emission Control System and Built After November 27, 1988
Bulletin No.: 617
Date: May, 1995

NOTE: This is an Emission Recall bulletin.

VEHICLES AFFECTED

1989 and 1990 Jeep Cherokee (XJ), Comanche (MJ) and Wrangler (YJ) Vehicles Equipped With a 2.5L Engine and a Federal Emission Control System and Built After November 27, 1988.

SERVICE INFORMATION

Failure of the oxygen sensor and catalytic converter on the listed models, may cause a vehicle to be in violation of U.S Environmental Protection Agency (EPA) Emissions Standards. To correct this condition, the oxygen sensor and catalytic converter must be replaced with improved design parts.

Details of this service action are explained in the following sections.

SERVICE PROCEDURE VIDEOTAPE

No videotape of the service procedure for this recall will be provided.

DEALER NOTIFICATION & VEHICLE LIST

INVOLVED DEALERS

Each dealer to whom involved vehicles were invoiced (or the current dealer at the same street address) will receive a copy of this dealer recall notification letter and a list of the involved vehicles by first class mail.

The Vehicle List is arranged in Vehicle Identification Number (VIN) sequence. Owners known to Chrysler are also listed. The lists are for dealer reference in arranging for service of involved vehicles as necessary.

ALL OTHER DEALERS

Each Jeep & Eagle dealer who does not receive a Vehicle List will receive a copy of this dealer recall notification letter by first class mail.

DIAL SYSTEM FUNCTION 70

All involved vehicles will be entered to DIAL System Function 70 at the time of recall implementation for dealer inquiry by VIN as needed.

PARTS

IMPORTANT: A quantity of parts will be distributed initially and billed to all involved dealers. This quantity will cover a portion of the total vehicles involved. Additional parts may be ordered as needed to support customer demand.

Each involved dealer, to whom vehicles in the recall were invoiced (or the current dealer at the same street address), will receive enough Emission Service Packages, Recall PN C3906170, to service 25% of those vehicles.

Each parts package contains the following components:

EMISSION SERVICE PACKAGE

Qty	Description	Qty	Description
1	Oxygen Sensor	1	Clamp
1	Catalytic Converter	4	Bolts
1	Gasket	4	Nuts
1	Recall Completion Label	1	Instruction Sheet

OWNER NOTIFICATION & SERVICE SCHEDULING

All involved vehicle owners known to Chrysler are being notified of the service requirement by first class mail. They are requested to schedule appointments for the service with their dealers at the earliest possible date. A copy of the CUSTOMER NOTIFICATION LETTER is in this bulletin.

Enclosed with each owner notification is an Owner Notification Form. The involved vehicle and recall are identified on the form for owner or dealer reference as needed.

SERVICE PROCEDURE

A. Replace Oxygen Sensor

1. Locate the oxygen sensor in the exhaust manifold as shown in Fig. 1.

2. Disconnect the oxygen sensor electrical connector.

3. Remove the oxygen sensor.

4. Clean the exhaust manifold threads using a thread chaser.

NOTE: Do not use solvents or lubricants on threads.

5. Install provided oxygen sensor. Tighten to 22 ft-lbs (30 N-m)

6. Connect oxygen sensor electrical connector.

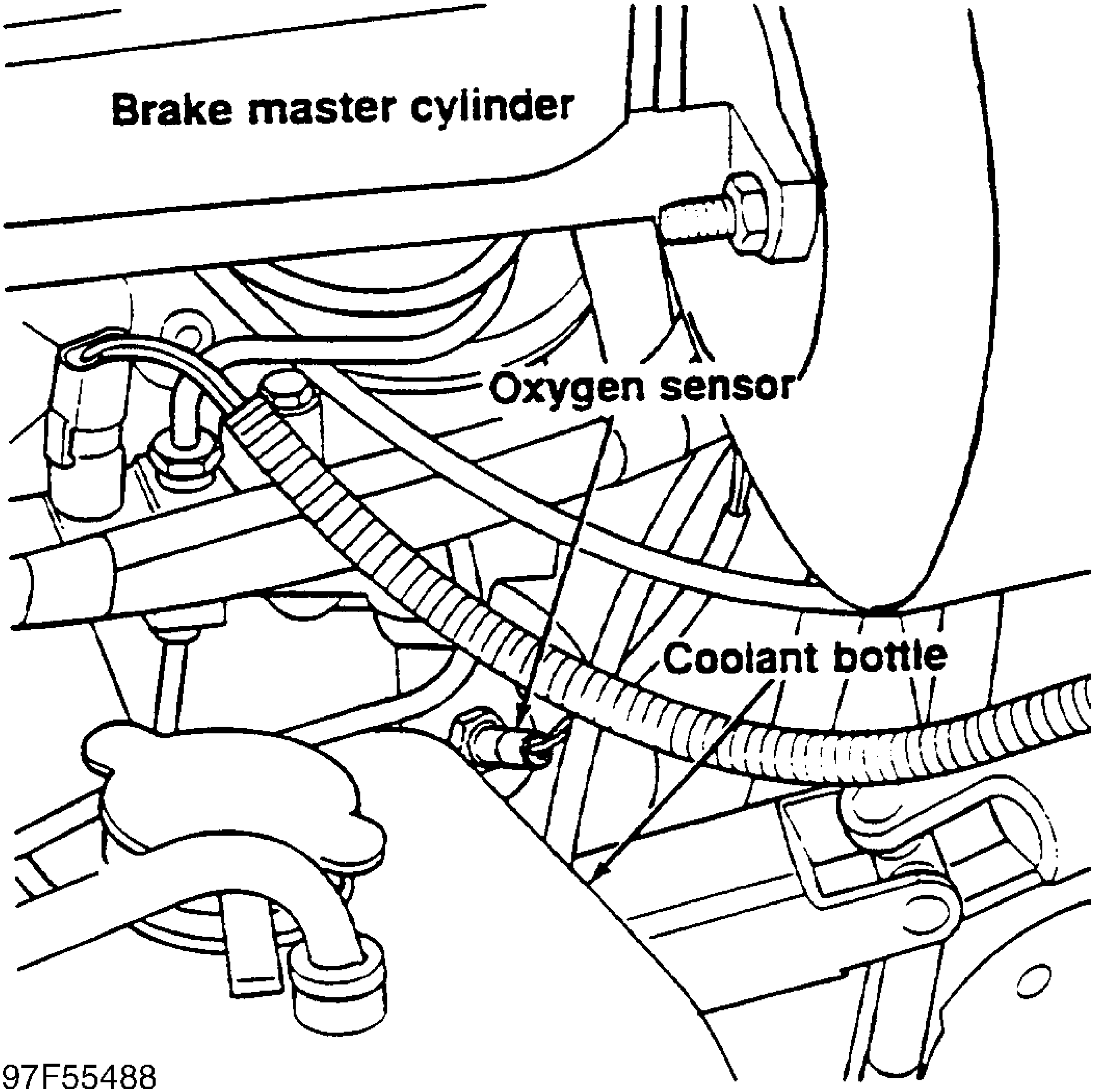

Fig. 1: Oxygen Sensor Location

B. Replace Catalytic Converter

WARNING: IF TORCHES ARE USED WHEN WORKING ON THE EXHAUST SYSTEM, DO NOT ALLOW THE FLAME NEAR THE FUEL LINES.

1. Remove and discard the nuts, bolts and gasket at the front of the converter and the exhaust pipe clamp at the rear (see Fig. 2).

NOTE: Use penetrating oil if necessary.

2. On Wrangler (YJ) vehicles: Support the transmission and remove the skid plate.

3. Place a block of wood against the rear of the converter and drive the clamp converter forward to disengage the alignment tab on the converter pipe from the alignment slot on the muffler.

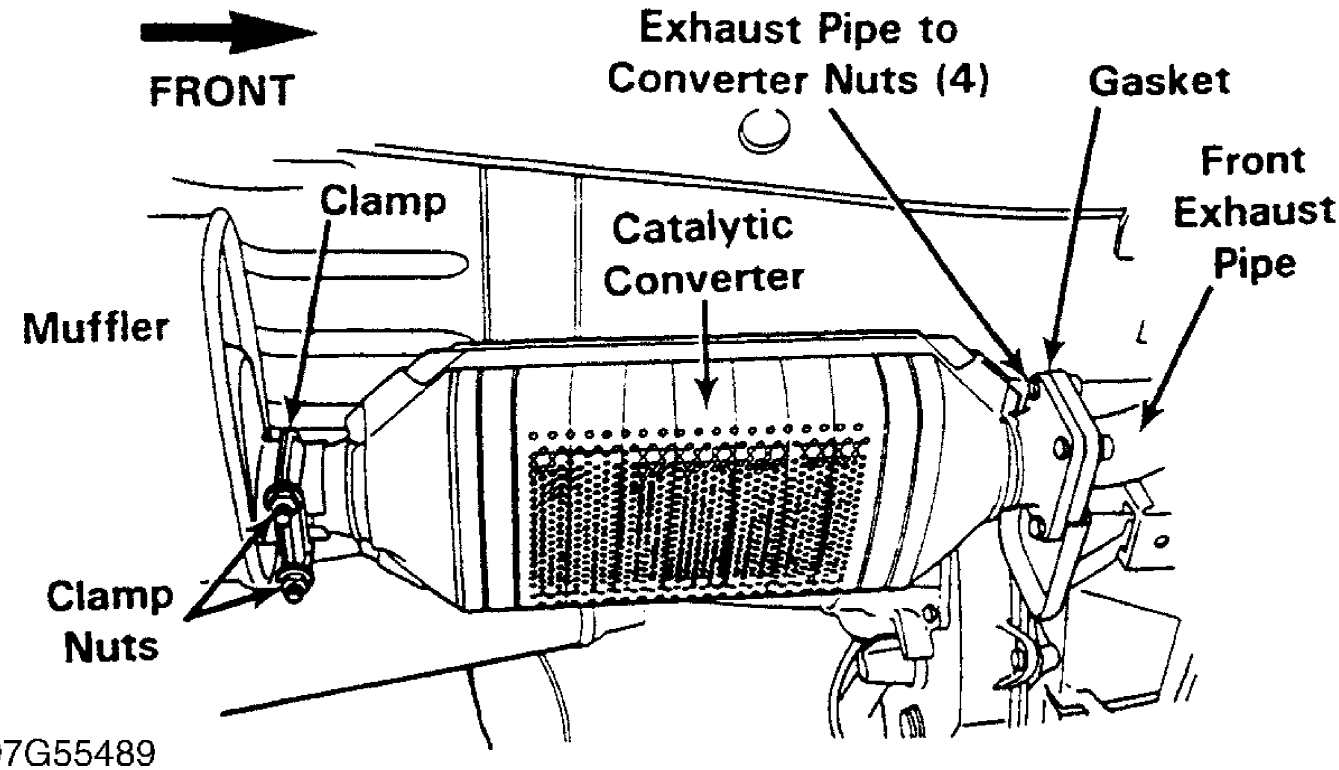

Fig. 2: Removing Converter and Exhaust Pipe Clamp

NOTE: If the converter does not move forward, it may be necessary to heat the converter to muffler connection with an oxyacetylene torch until the metal becomes cherry red.

4. Twist the converter back and forth to separate it from the muffler.

5. Install the new converter into the muffler until the alignment tab is inserted into the alignment slot.

6. Using the provided gasket, nuts and bolts, attach the converter to the front exhaust pipe. Do not tighten the bolts.

7. Install and tighten the new exhaust pipe clamp, at the muffler to converter connection, to 40 ft-lbs (57 N-m).

8. Tighten the converter to front exhaust pipe bolts to 25 ft-lbs (34 N-m).

9. On Wrangler (YJ) vehicles: Install the skid plate.

10. Lower vehicle.

C. Install Recall Completion Label

1. With a ball point pen, print your dealer code (5 digits) on the supplied Recall Completion Label.

2. Peel the label from its backing and apply it near the Vehicle Emissions Control Information Label on the underside of the hood.

D. Complete Proof of Correction Form

1. Complete a Vehicle Emission Recall Proof of Correction Form and supply it to the vehicle owner.

COMPLETION REPORTING AND REIMBURSEMENT

Claims for vehicles which have been serviced must be submitted on the DIAL System Claims submitted will be used by Chrysler to record recall service completions and provide dealer payments.

Use the following labor operation number and time allowance:

	Labor Operation Number	Time Allowance
Replace oxygen sensor and catalytic converter	25617182	0.8 Hours

Add the cost of the recall parts package plus applicable dealer allowance to your claim.

PARTS RETURN

Removed catalytic converters must be returned to the Warranty Material Return Center.

NOTE: See Warranty Policy and Procedure Manual, Chapter 6, Subsection H for complete recall claim processing and material return instructions.

VEHICLE NOT AVAILABLE

If a vehicle is not available for service for a known reason, let us know by filling out the pre-addressed Vehicle Disposition Form portion of the Owner Notification Form, or describe the reason on a postcard and mail to:

Chrysler Corporation 429-10-04
P.O. Box 1919
Detroit, Michigan 48231-1919

Following the above procedures will expedite the processing of your claim.

If you have any questions or need assistance in completing this action, please contact your Zone Service Office.

Customer Services Field Operations
Chrysler Corporation

CUSTOMER NOTIFICATION LETTER

EMISSIONS RECALL TO REPLACE YOUR VEHICLE'S
OXYGEN SENSOR AND CATALYTIC CONVERTER

Dear Jeep Vehicle Owner:

Chrysler Corporation has determined that some 1989 and 1990 Jeep Cherokee, Comanche and Wrangler vehicles equipped with a 2.5L engine, may be in violation of Federal Emissions Standards.

The Problem is... The oxygen sensor and catalytic convener on your vehicle (identified on the enclosed form), may be susceptible to failure. This could result in hydrocarbon (HC), carbon monoxide (CO) and oxides of nitrogen (NOx) emission levels above the allowable limits, which were established to protect the public health from the dangers of air pollution.

What you must do...

* Simply contact your Jeep dealer to schedule a service appointment. Ask the dealer to hold parts for your vehicle or order them prior to your appointment.

* Bring the enclosed Owner Notification Form with you to your dealer. It tells the dealer what service is required for your vehicle.

What Chrysler and your dealer will do... Chrysler will repair your vehicle free of charge (parts and labor). To do this, your dealer will replace the oxygen sensor and catalytic converter. The service will take about one hour but additional time may be required depending on how service work is scheduled and processed.

If you need help... If you have trouble getting your vehicle repaired, please call the Chrysler Customer Center, toll free, at 1-800-853-1403. A representative will assist you in getting your vehicle repaired. If you are still unable to obtain the repair as described in this letter within a reasonable time, you may also contact the Manufacturers Operations Division of the Environmental Protection Agency (6405J), 401 M Street, S.W., Washington, D.C. 20460.

In order to ensure your full protection under the emission warranty made applicable to your vehicle under Federal law, and your right to participate in future recalls, it is recommended that you have your vehicle serviced as soon as possible. Failure to do so could legally be determined to be a lack of proper maintenance of your vehicle. Further, without this repair your vehicle may fail a state or local emission inspection test.

We're sorry for any inconvenience, but trust that you understand our interest in clean air and your continuing satisfaction with our product. Thanks for your attention to this important matter.

Customer Services Field Operations
Chrysler Corporation

EMISSIONS STANDARDS

1988 Jeep Cherokee

1988 EMISSION & TUNE-UP STANDARDS

MANUFACTURING STANDARDS

Federal and state governments have established air quality standard during the past 20 years. Automobile manufacturers design their vehicles to conform to standards where the vehicle will be sold and operated. These standards cover carbon monoxide (CO), hydrocarbons (HC) and oxides of nitrogen (NOx).

Federal and California Standards which must be met by manufacturers are specified in units easily measured in a testing laboratory. Since 1970, these standards have been in "grams per mile". This means no vehicle, whether 2-cylinder or V8, may emit more than a set weight (in grams) of pollutants for each mile travelled. Since large engines burn more fuel per mile than do small engines, they must be "cleaner" per gallon burned if they are to meet these standards.

When manufacturers certify vehicle models prior to sale, the vehicles are placed on a dynamometer and the exhaust gases are collected in a bag. After the vehicle runs for a specified time, the gases are analyzed and weighed. Engines and emission systems are designed so the weight of emissions will be less than the specified grams per mile standard.

Infra-red exhaust analyzers are commonly used in vehicle test stations. The analyzer uses a test probe placed in the exhaust stream to sample the exhaust gases, and measure the percentage of CO and the parts per million of HC. These are not the same units used by the manufacturer when the vehicle is certified. The NOx emissions cannot be measured by an infra-red exhaust analyzer. Laboratory equipment must be used to determine NOx emissions.

TUNE-UP STANDARDS

The technician must use the proper specifications when adjusting the vehicle during a tune-up. The first few years of emission-regulated vehicles were adjusted using an exhaust gas analyzer which measured CO and HC.

In the past few years, manufacturers have produced much cleaner running vehicles. The CO (percentage) and HC (ppm) have become very low, especially when measured downstream of catalytic converter. It has become difficult to measure the effect of fuel and ignition adjustments.

One solution to this problem for vehicles using carburetors requires the use of artificially-enriched propane adjustments. The added propane increases or decreases engine RPM for evaluation of carburetor rich/lean setting. This allows the technician to check carburetor setting quickly and accurately.

As computer-controlled systems were developed, it became possible for the vehicles to adjust the air/fuel ratio, ignition timing and emission control device operation throughout the entire driving range. These computer control systems use a variety of sensors that provide the electronic control unit with information on vehicle speed, altitude of vehicle operation and transmission gear position, along with engine operating conditions.

Fuel delivery to achieve a lean air/fuel ratio is controlled by the computer. The computer controls the on/off (duty cycle) time of the fuel injector(s) or carburetor mixture control solenoid to achieve leanest possible air/fuel ratio while maintaining good driveability.

Although most repair shops have exhaust gas analyzers, computer-controlled vehicles normally do not have a CO and HC

specification for tuning. An abnormal exhaust gas reading on an exhaust analyzer may be helpful in diagnosing a problem, but should not be used as a basis for adjustments.

These procedures and specifications are supplied by the manufacturer and may not list CO or HC specifications.

STATE TEST STANDARDS

Some states have established standards for allowable pollutants for used vehicles. These standards are normally given in CO (percentage) and HC (ppm). Vehicle tail-pipe emissions can be checked against the standard using an exhaust gas analyzer. Typical standards for newer vehicles would be 0.5 percent CO and 200 ppm HC. If vehicle emissions are below this standard, vehicle would pass emissions test. These standards are used to determine if the vehicle is running properly, not to be used for tuning or adjusting the engine. If the vehicle will not pass emission test or is running poorly, use the manufacturer's diagnostic procedures and specifications for repair.

Test standards may change each year and vary from state to state, and even by county within each state. It is not possible to provide an accurate and up-to-date list of emissions standards. Emission standards can be obtained for your area by contacting your local county or state office. Remember, the emission standards are only for test purposes. The manufacturer's adjustment procedures and specifications must be followed when repairing vehicles.

ENGINE COOLING FAN

1988 Jeep Cherokee

1987-88 ENGINE COOLING
Thermostatically Controlled Electric Fans

Cherokee, Comanche, Wagoneer

DESCRIPTION & OPERATION

On Cherokee, Comanche and Wagoneer models with a 4.0L engine, A/C and/or heavy duty cooling system, an auxiliary electric fan is used. The auxiliary fan is controlled by a relay mounted on the left inner fender panel. A radiator temperature switch attached to the radiator outlet tank above the lower radiator hose senses engine coolant temperature.

When coolant temperature is more than 190(0)F (88(0)C), the radiator coolant temperature switch closes allowing current from the ignition switch to flow through the fan relay to ground activating the relay. When relay is activated, battery voltage is supplied to the fan causing it to operate. When coolant temperature is below 190(0)F (88(0)C), the radiator coolant temperature switch opens preventing the relay from being grounded and electric cooling fan from being energized.

When the A/C (if equipped) is turned on, the Electronic Control Unit (ECU) grounds the A/C relay coil allowing current to flow through it. This activates the A/C relay which then supplies current to the A/C clutch, fan diode assembly and cooling fan relay. The cooling fan relay is activated and the fan operates. Whenever the A/C is used, regardless of engine coolant temperature, the auxiliary electric cooling fan operates.

TESTING

NOTE: For following tests, refer to fan relay connector terminal identification and fan controls identification. See Figs. 1 and 2.

With Air Conditioning

1) If electric cooling fan does not work all the time, go to step 3). If electric cooling fan is inoperative when A/C compressor operates, start engine and turn A/C on. Disconnect fan relay connector. Fan relay is located on left inner fender panel.

2) Using a voltmeter, check for voltage at fan relay connector terminal No. 2. If voltmeter does not read battery voltage, replace fan diode assembly.

3) Disconnect fan relay connector. Fan relay is located on left inner fender panel. Using a jumper wire with an in-line 25-amp fuse, supply battery voltage to fan relay connector terminal No. 4.

4) If fan operates, motor is okay. Go to next step. If fan motor does not operate, check continuity between fan relay connector terminal No. 4 and body ground connections. If continuity exists, replace fan motor. If continuity does not exist, repair open and retest.

5) Disconnect fan relay connector. Turn ignition switch to the "RUN" position. Check continuity between fan relay connector terminal No. 5 and body ground connections. If continuity does not exist, repair open circuit. If continuity exists, go to next step.

6) Using a jumper wire with an in-line 25-amp fuse, jump across fan relay connector terminals No. 1 and No. 4. If fan motor operates, go to next step. If fan motor does not operate, repair fan

relay fuse link.

7) Check for battery voltage at fan relay connector terminal No. 2. Connect a jumper wire across radiator temperature switch connector. Radiator temperature switch is located on radiator outlet tank, above lower radiator hose. If fan does not operate, replace radiator temperature switch. If fan operates, go to next step.

8) Check for battery voltage at fan relay connector terminal No. 2. If battery voltage is not present, replace fan diode assembly.

Without Air Conditioning

1) Disconnect fan relay. Fan relay is mounted on left inner fender panel. Using a jumper wire with an in-line 25-amp fuse, supply battery voltage to fan relay connector terminal No. 4.

2) If fan operates, motor is okay. Go to next step. If fan motor does not operate, check continuity between fan relay connector terminal No. 4 and body ground connections.

If continuity exists, replace fan motor. If continuity does not exist, repair open and retest.

3) With fan relay connector disconnected, turn ignition switch to the "RUN" position. Check continuity between fan relay connector terminal No. 5 and body ground connections. If continuity does not exist, repair open. If continuity exists, go to next step.

4) Using a jumper wire with a 25-amp in-line fuse, jump across fan relay connector terminals No. 1 and No. 4. If fan motor operates, leave jumper wire connected and proceed to next step. If fan motor does not operate, repair fan relay fuse link.

5) Check for battery voltage at cooling fan relay connector terminal No. 2. Connect a jumper wire across radiator coolant temperature switch connector. Radiator coolant temperature switch is located on radiator outlet tank above lower radiator hose. If fan does not operate, replace radiator coolant temperature switch.

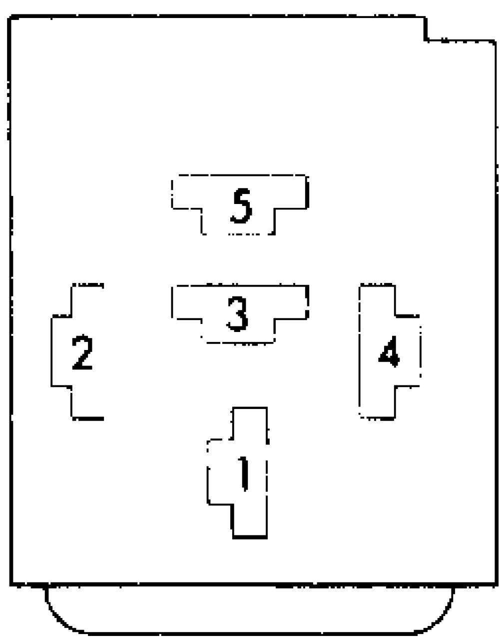

Fig. 1: Fan Relay Connector Terminal Identification
Courtesy of Chrysler Motors.

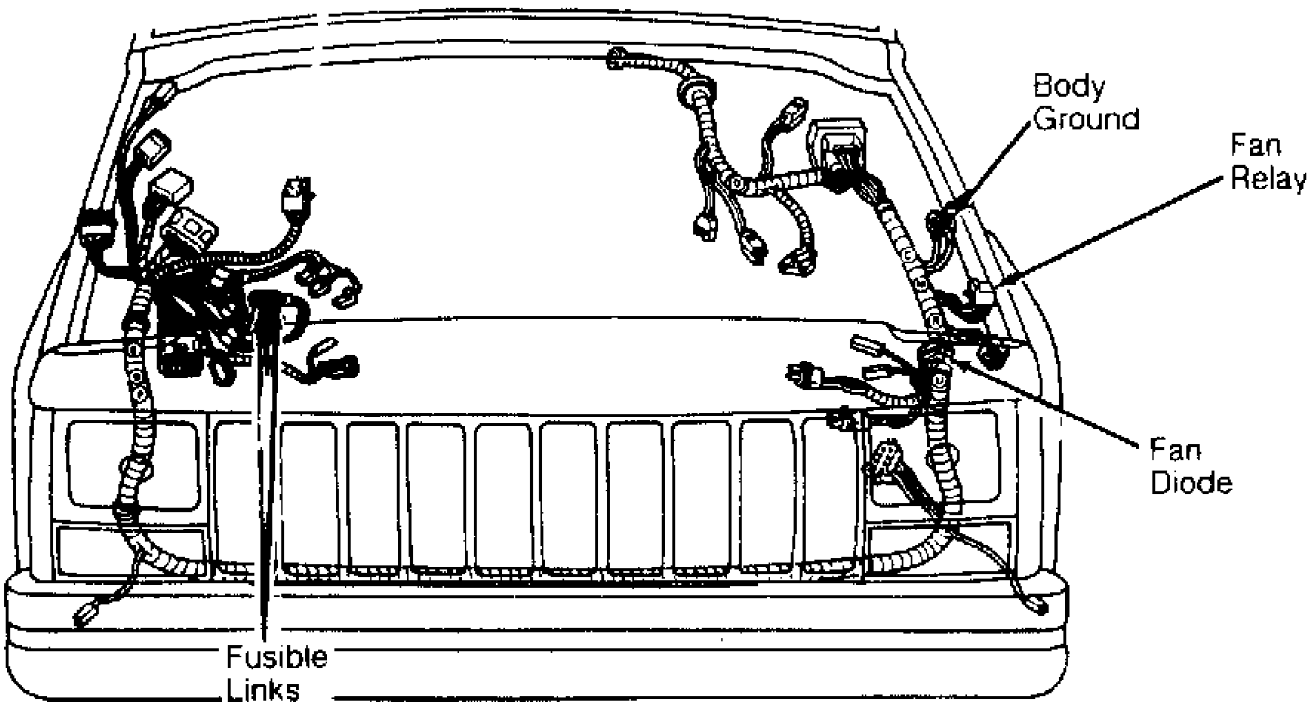

Fig. 2: Fan Controls Identification
Courtesy of Chrysler Motors.

REMOVAL & INSTALLATION

AUXILIARY ELECTRIC COOLING FAN

Removal

1) Auxiliary fan is attached to radiator upper crossmember behind radiator.

2) Remove fan retaining screws from radiator upper crossmember. Disconnect electric fan connector. Lift fan straight up out of vehicle.

Disassembly

Components of auxiliary electric cooling fan can be replaced. However, components cannot be repaired. If an auxiliary cooling fan component needs repair it must be replaced with the recommended replacement part only. The auxiliary fan consists of a fan module, fan module retaining clip, fan shroud, and fan motor.

1) Place assembly on bench with fan blades facing up. Position an awl between the fan retainer and motor shaft. Pry the retainer off the motor shaft. Slide fan up off of motor.

2) Unwind fan motor electrical connector from retaining clips of fan shroud.

3) Remove fan motor mounting screws. Remove fan.

Assembly

1) Attach fan motor to fan shroud with mounting screws. Wind electrical connector into retaining clips of fan shroud.

The bushing at fan module center has a small groove on the bottom side of it that fits over the alignment dowel on the fan motor shaft. The keyway pin of the alignment dowel fits into the groove in fan motor shaft. A small amount of silicone sealant placed in the groove of the fan motor shaft holds the alignment dowel in place.

2) Place fan module over motor shaft, align groove in fan module with dowel on motor shaft. Start fan module retainer onto the fan motor shaft with open end of the retainer facing the groove in the shaft. When retainer is completely installed the open end will be on side opposite the groove. Use needle nose pliers to finish installing retainer.

Installation

Align lower retaining tabs of fan shroud with slots in bracket at bottom of radiator and push fan down into position. Tighten mounting screws to 36 inch lbs. (4.07 N.m). Connect auxiliary cooling fan electrical connector.

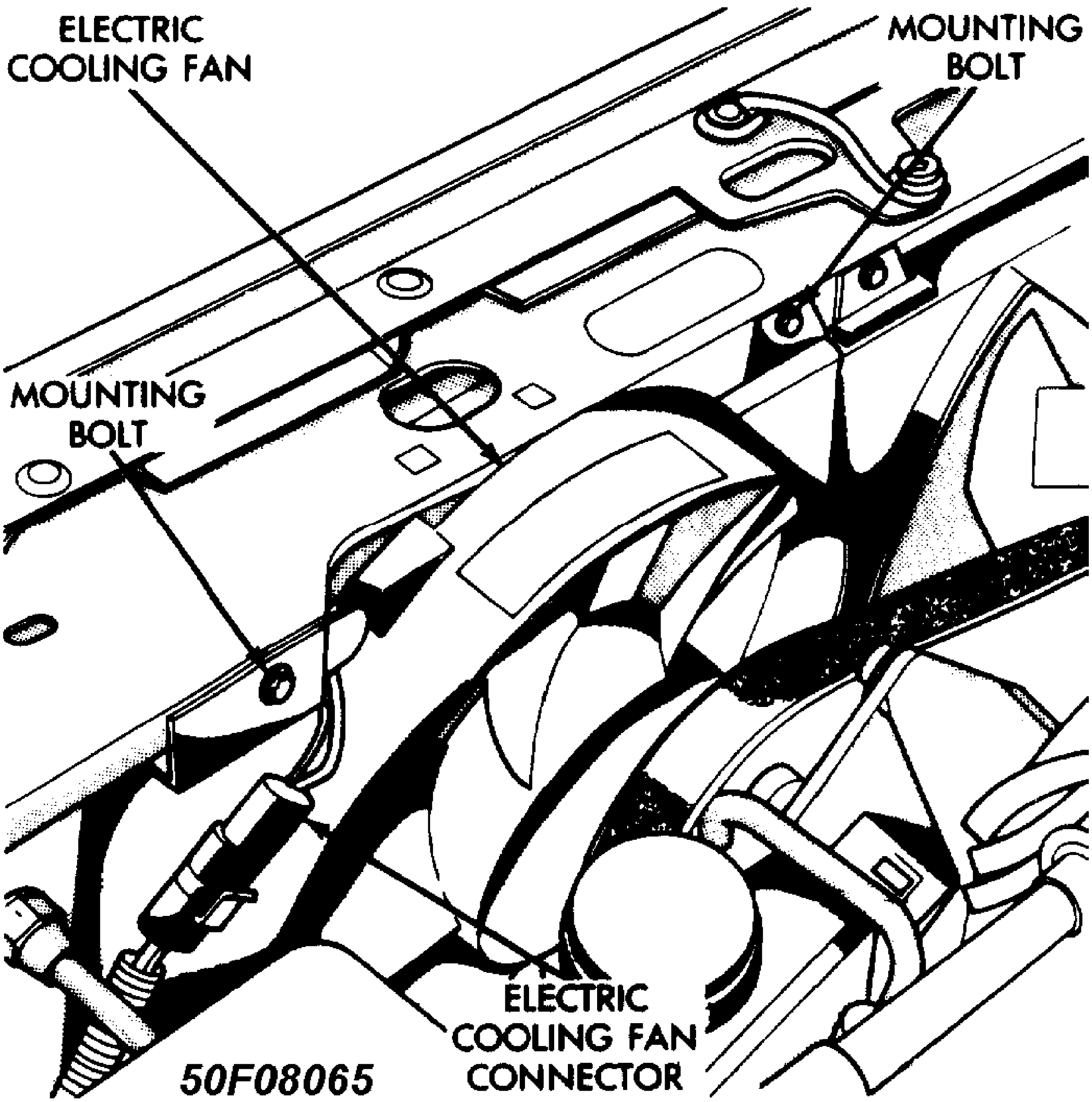

Fig. 3: Auxiliary Fan Removal & Installation

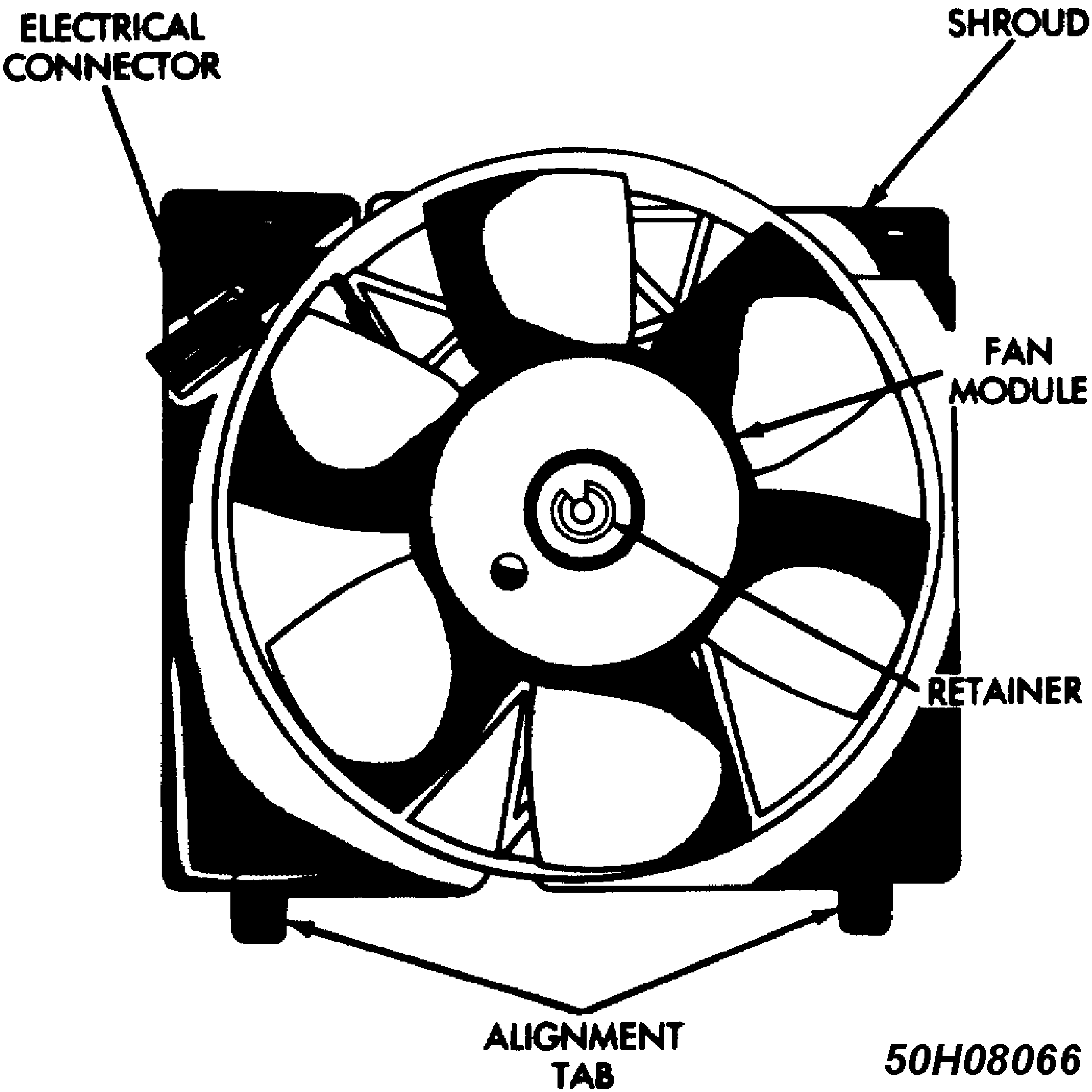

Fig. 4: Auxiliary Fan

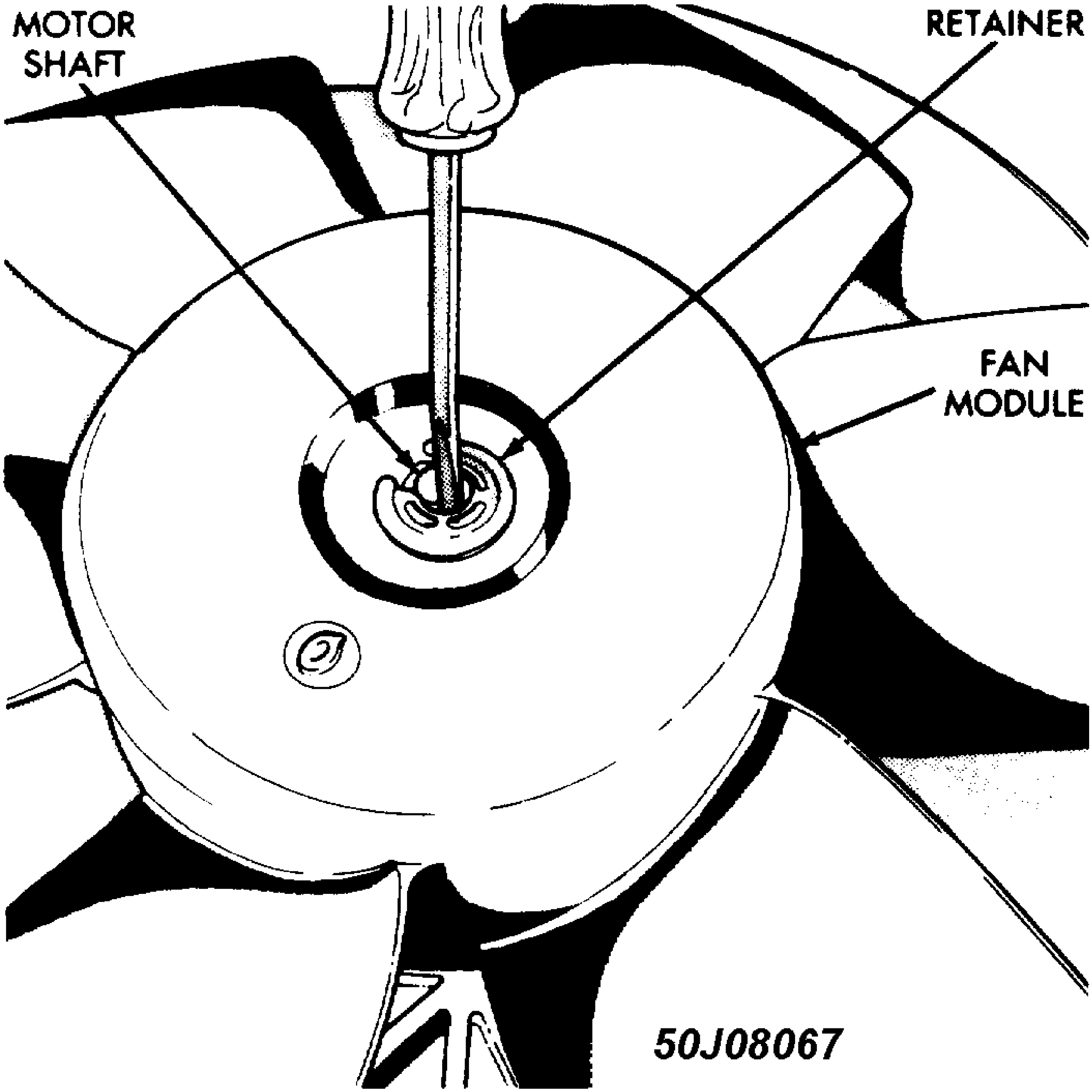

Fig. 5: Fan Module Removal

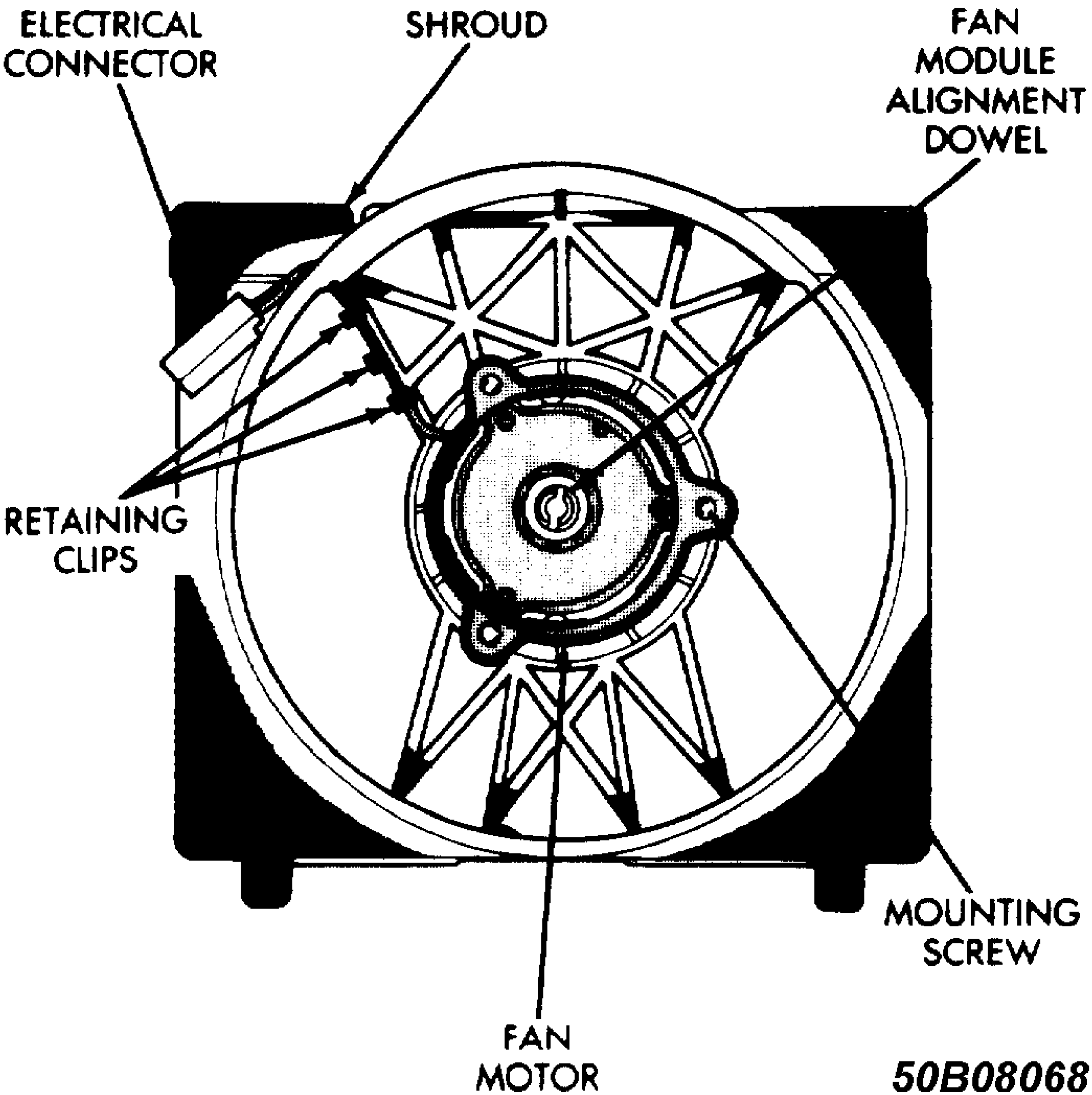

Fig. 6: Fan Motor Removal & Installation

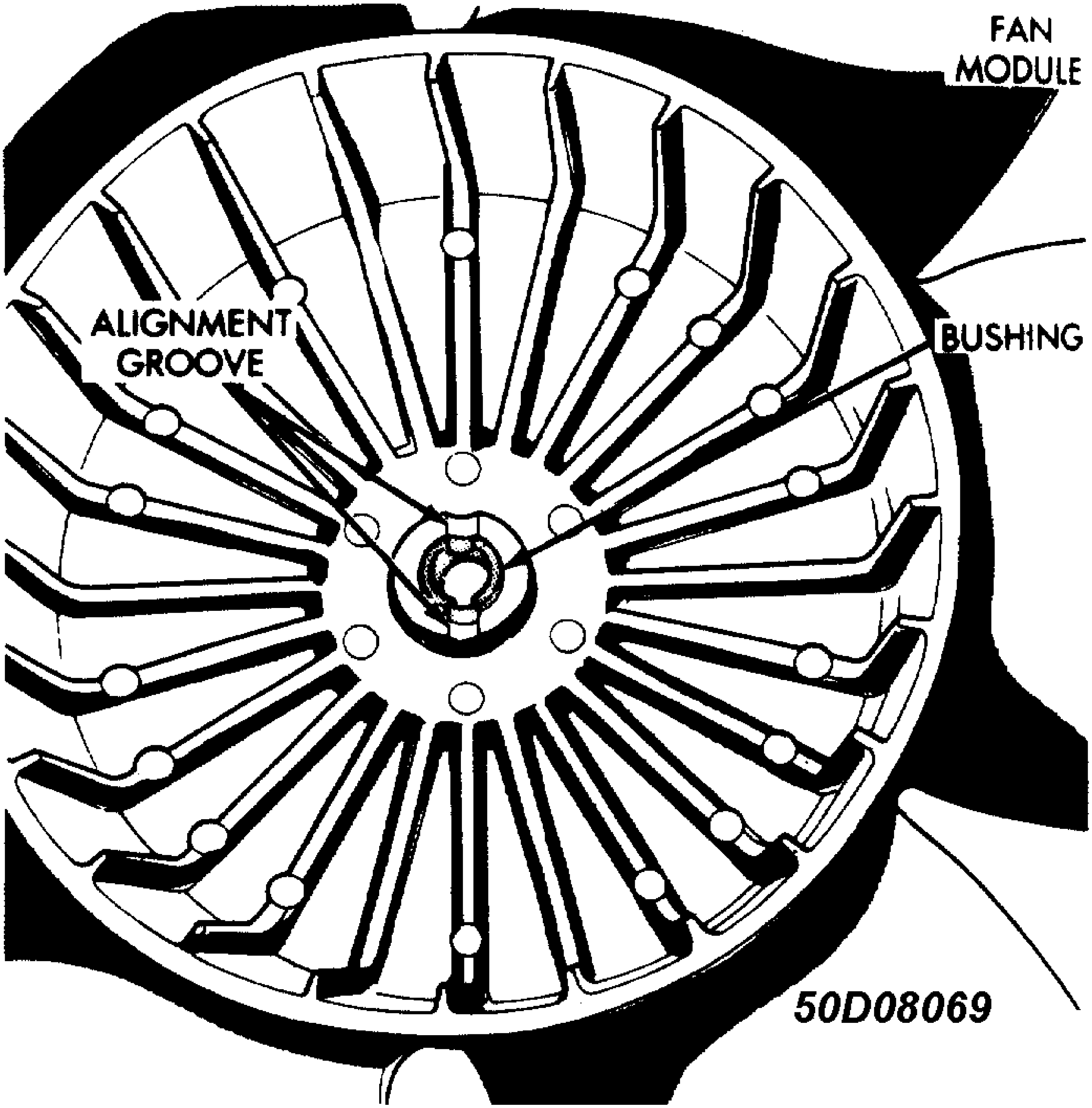

Fig. 7: Alignment Groove in Fan Module Bushing

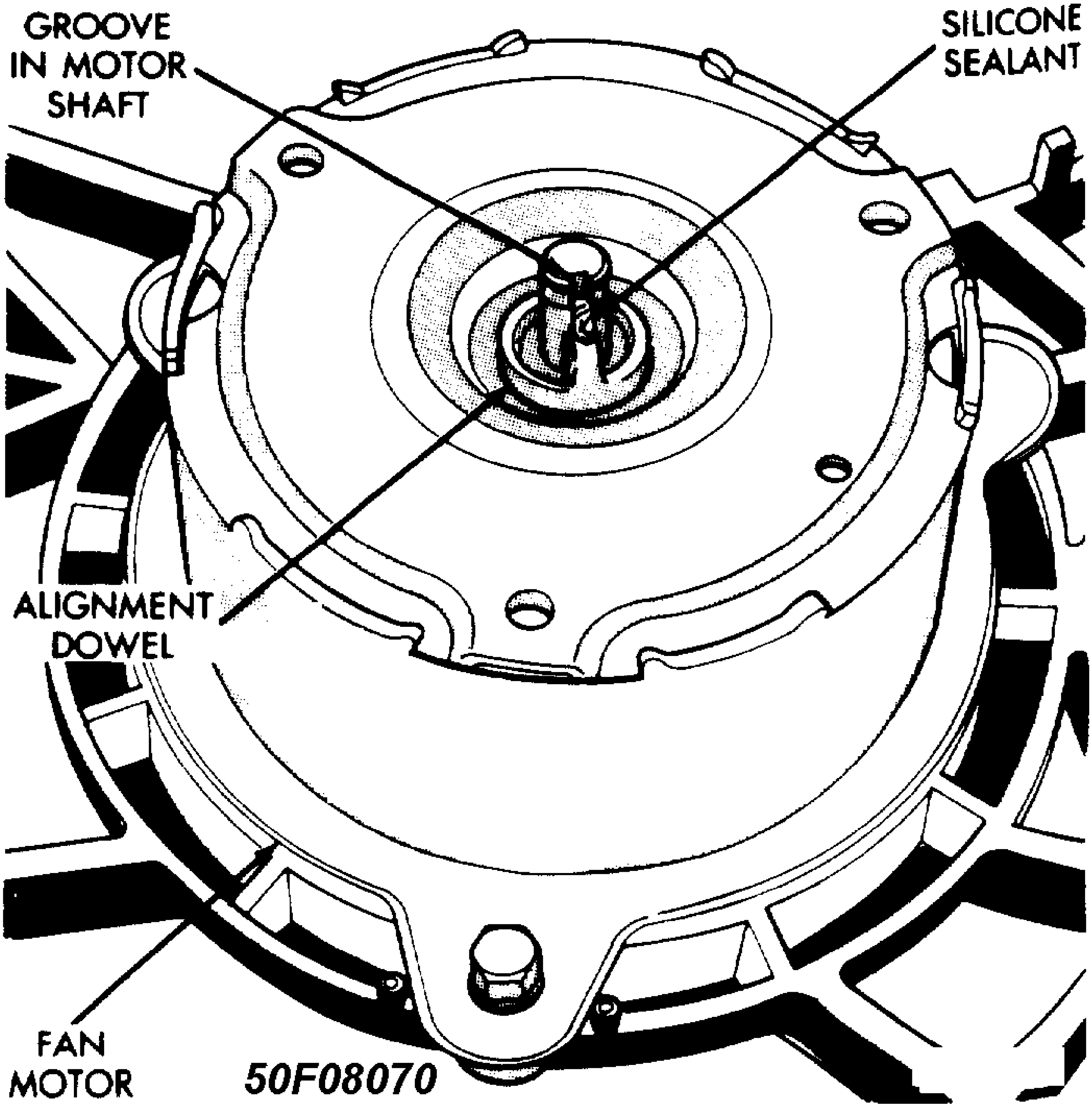

Fig. 8: Alignment Dowel (Fan Module to Motor)

WIRING DIAGRAMS

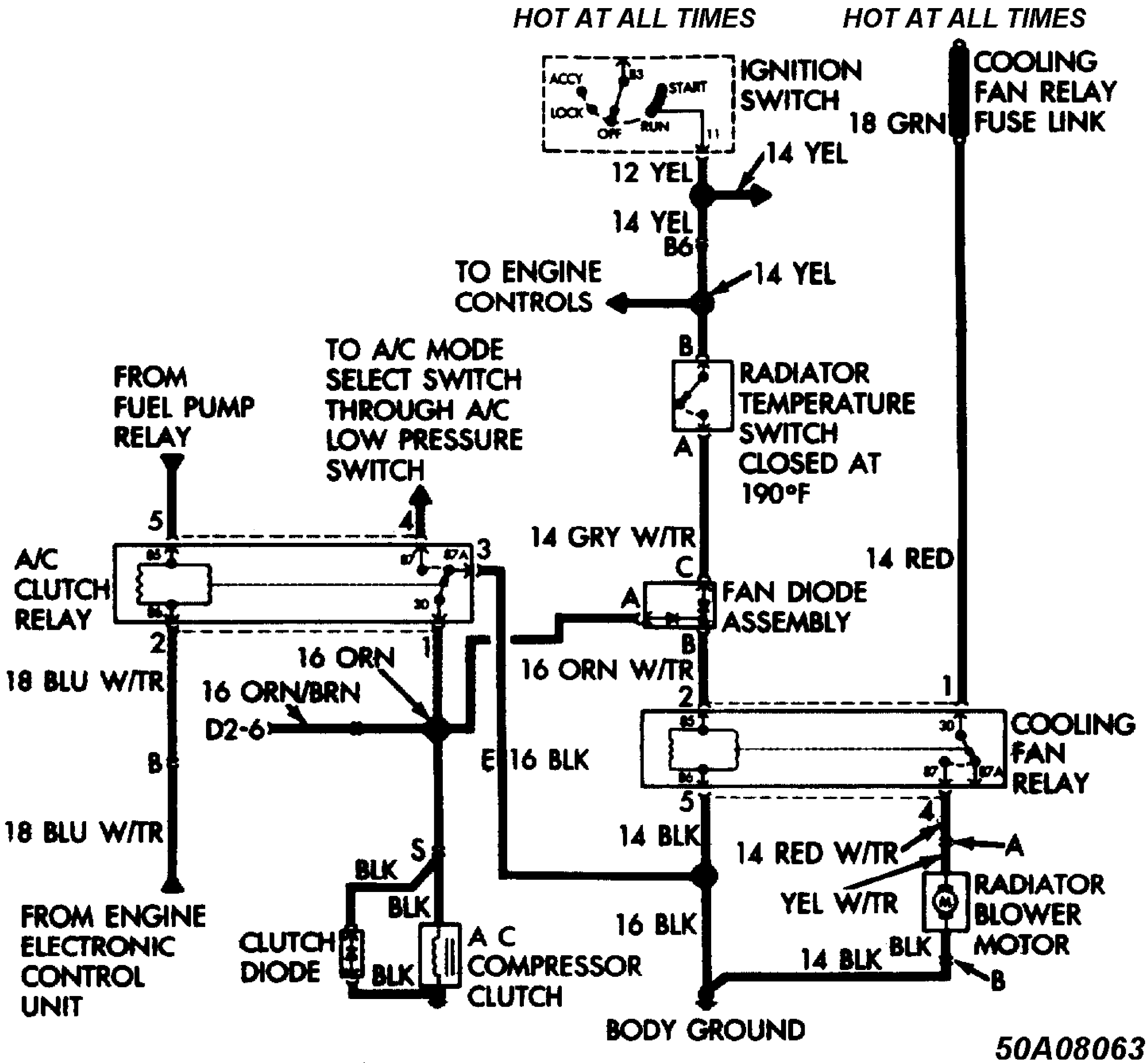

Fig. 9: Wiring Diagrams (With A/C)

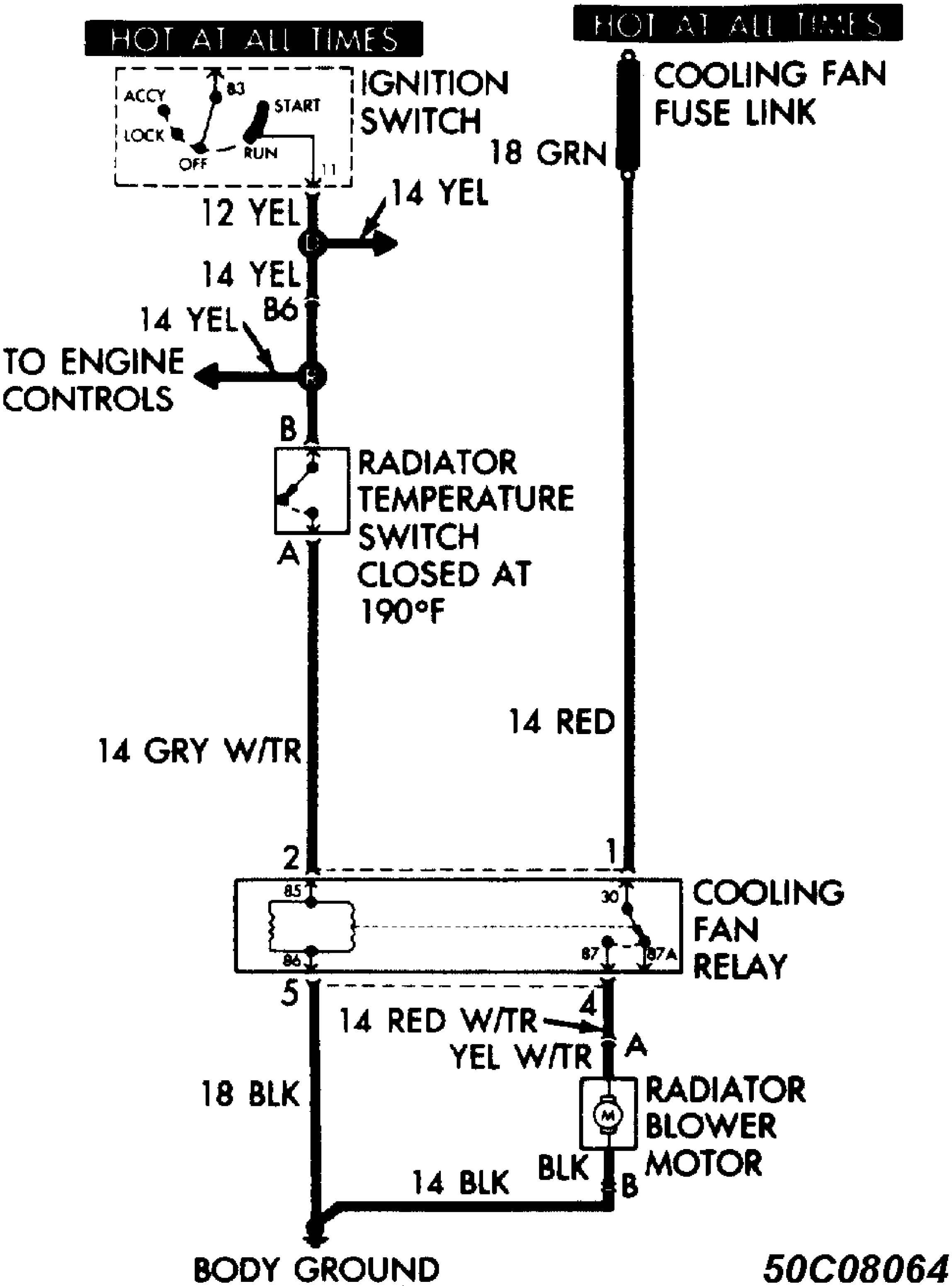

Fig. 10: Wiring Diagrams (Without A/C)

ENGINE OIL PAN REMOVAL

1988 Jeep Cherokee

1988 ENGINES
Jeep - Engine Oil Pan Removal

Cherokee, Comanche, Wagoneer
Wrangler, Grand Wagoneer

NOTE: Only engine applications with special oil pan removal and installation procedures are included in this article. Illustrations of most manufacturer's oil pans and attaching hardware are provided.

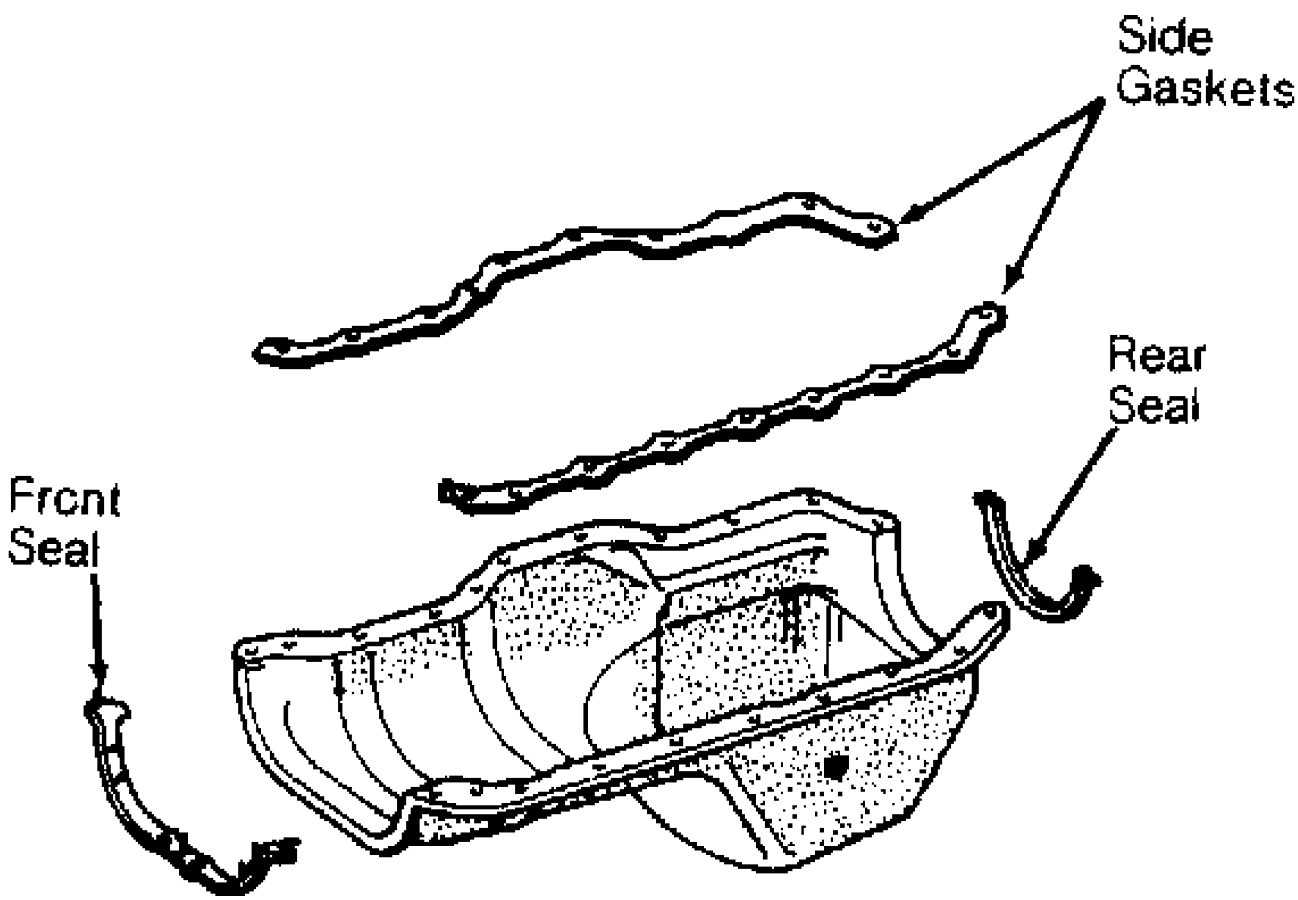

Fig. 1: View of Jeep 2.5L Oil Pan
Courtesy of Chrysler Motors.

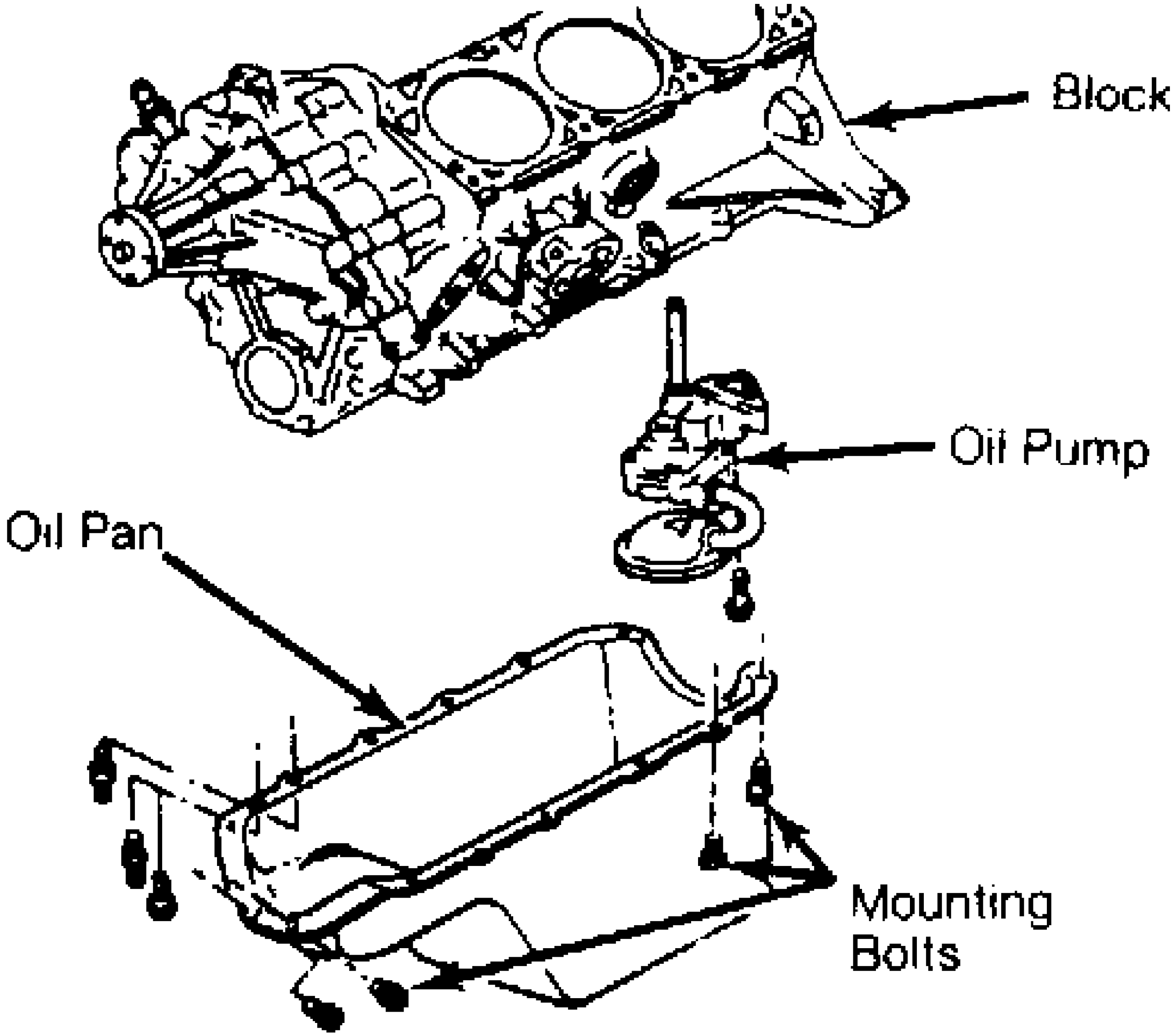

Fig. 2: View of Jeep 4.0L & 4.2L Oil Pan
Courtesy of Chrysler Motors.

ENGINE OVERHAUL PROCEDURES - GENERAL INFORMATION

1988 Jeep Cherokee

Engine Overhaul Procedures - General Information
ALL PISTON ENGINES

* PLEASE READ THIS FIRST *

Examples used in this article are general in nature and do not necessarily relate to a specific engine or system. Illustrations and procedures have been chosen to guide mechanic through engine overhaul process. Descriptions of processes of cleaning, inspection, assembly and machine shop practice are included.

Always refer to appropriate engine overhaul article in the ENGINES section for complete overhaul procedures and specifications for the vehicle being repaired.

ENGINE IDENTIFICATION

The engine may be identified from its Vehicle Identification Number (VIN) stamped on a metal tab. Metal tab may be located in different locations depending on manufacturer. Engine identification number or serial number is located on cylinder block. Location varies with manufacturer.

INSPECTION PROCEDURES

* PLEASE READ THIS FIRST *

NOTE: Always refer to appropriate engine overhaul article in the ENGINES section for complete overhaul procedures and specifications for the vehicle being repaired.

GENERAL

Engine components must be inspected to meet manufacturer's specifications and tolerances during overhaul. Proper dimensions and tolerances must be met to obtain proper performance and maximum engine life.

Micrometers, depth gauges and dial indicator are used for checking tolerances during engine overhaul. Magnaflux, Magnaglo, dye-check, ultrasonic and x-ray inspection procedures are used for parts inspection.

MAGNETIC PARTICLE INSPECTION

Magnaflux & Magnaglo

Magnaflux is an inspection technique used to locate material flaws and stress cracks. The part in question is subjected to a strong magnetic field. The entire part, or a localized area, can be magnetized. The part is coated with either a wet or dry material that contains fine magnetic particles.

Cracks which are outlined by the particles cause an interruption in the magnetic field. The dry powder method of Magnaflux can be used in normal light. A crack will appear as an obvious bright line.

Fluorescent liquid is used in conjunction with a blacklight in a second Magnaflux system called Magnaglo. This type of inspection demands a darkened room. The crack will appear as a glowing line in this process. Both systems require complete demagnetizing upon

completion of the inspection. Magnetic particle inspection applies to ferrous materials only.

PENETRANT INSPECTION

Zyglo

The Zyglo process coats the material with a fluorescent dye penetrant. The part is often warmed to expand cracks that will be penetrated by the dye. When the coated part is subjected to inspection with a blacklight, a crack will glow brightly. Developing solution is often used to enhance results. Parts made of any material, such as aluminum cylinder heads or plastics, may be tested using this process.

Dye Check

Penetrating dye is sprayed on the previously cleaned component. Dye is left on component for 5-45 minutes, depending upon material density. Component is then wiped clean and sprayed with a developing solution. Surface cracks will show up as a bright line.

ULTRASONIC INSPECTION

If an expensive part is suspected of internal cracking, Ultrasonic testing is used. Sound waves are used for component inspection.

X-RAY INSPECTION

This form of inspection is used on highly stressed components. X-ray inspection maybe used to detect internal and external flaws in any material.

PRESSURE TESTING

Cylinder heads can be tested for cracks using a pressure tester. Pressure testing is performed by plugging all but one of the holes in the head and injecting air or water into the open passage. Leaks are indicated by the appearance of wet or damp areas when using water. When air is used, it is necessary to spray the head surface with a soap solution. Bubbles will indicate a leak. Cylinder head may also be submerged in water heated to specified temperature to check for cracks created during heat expansion.

CLEANING PROCEDURES

* PLEASE READ THIS FIRST *

NOTE: Always refer to appropriate engine overhaul article in the ENGINES section for complete overhaul procedures and specifications for the vehicle being repaired.

GENERAL

All components of an engine do not have the same cleaning requirements. Physical methods include bead blasting and manual removal. Chemical methods include solvent blast, solvent tank, hot tank, cold tank and steam cleaning of components.

BEAD BLASTING

Manual removal of deposits may be required prior to bead blasting, followed by some other cleaning method. Carbon, paint and

rust may be removed using bead blasting method. Components must be free of oil and grease prior to bead blasting. Beads will stick to grease or oil soaked areas causing area not to be cleaned.

Use air pressure to remove all trapped residual beads from components after cleaning. After cleaning internal engine parts made of aluminum, wash thoroughly with hot soapy water. Component must be thoroughly cleaned as glass beads will enter engine oil resulting in bearing damage.

CHEMICAL CLEANING

Solvent tank is used for cleaning oily residue from components. Solvent blasting sprays solvent through a siphon gun using compressed air.

The hot tank, using heated caustic solvents, is used for cleaning ferrous materials only. DO NOT clean aluminum parts such as cylinder heads, bearings or other soft metals using the hot tank. After cleaning, flush parts with hot water.

A non-ferrous part will be ruined and caustic solution will be diluted if placed in the hot tank. Always use eye protection and gloves when using the hot tank.

Use of a cold tank is for cleaning of aluminum cylinder heads, carburetors and other soft metals. A less caustic and unheated solution is used. Parts may be lift in the tank for several hours without damage. After cleaning, flush parts with hot water.

Steam cleaning, with boiling hot water sprayed at high pressure, is recommended as the final cleaning process when using either hot or cold tank cleaning.

COMPONENT CLEANING

* PLEASE READ THIS FIRST *

NOTE: Always refer to appropriate engine overhaul article in the ENGINES section for complete overhaul procedures and specifications for the vehicle being repaired.

SHEET METAL PARTS

Examples of sheet metal parts are the rocker covers, front and side covers, oil pan and bellhousing dust cover. Glass bead blasting or hot tank may be used for cleaning.

Ensure all mating surfaces are flat. Deformed surfaces should be straightened. Check all sheet metal parts for cracks and dents.

INTAKE & EXHAUST MANIFOLDS

Using solvent cleaning or bead blasting, clean manifolds for inspection. If the intake manifold has an exhaust crossover, all carbon deposits must be removed. Inspect manifolds for cracks, burned or eroded areas, corrosion and damage to fasteners.

Exhaust heat and products of combustion cause threads of fasteners to corrode. Replace studs and bolts as necessary. On "V" type intake manifolds, the sheet metal oil shield must be removed for proper cleaning and inspection. Ensure that all manifold parting surfaces are flat and free of burrs.

CYLINDER HEAD REPLACEMENT

* PLEASE READ THIS FIRST *

NOTE: Always refer to appropriate engine overhaul article in the ENGINES section for complete overhaul procedures and specifications for the vehicle being repaired.

REMOVAL

Remove intake and exhaust manifolds and valve cover. Cylinder head and camshaft carrier bolts (if equipped), should be removed only when the engine is cold. On many aluminum cylinder heads, removal while hot will cause cylinder head warpage. Mark rocker arm or overhead cam components for location.

Remove rocker arm components or overhead cam components. Components must be installed in original location. Individual design rocker arms may utilize shafts, ball-type pedestal mounts or no rocker arms. For all design types, wire components together and identify according to the corresponding valve. Remove cylinder head bolts. Note length and location. Some applications require cylinder head bolts be removed in proper sequence to prevent cylinder head damage. See Fig. 1. Remove cylinder head.

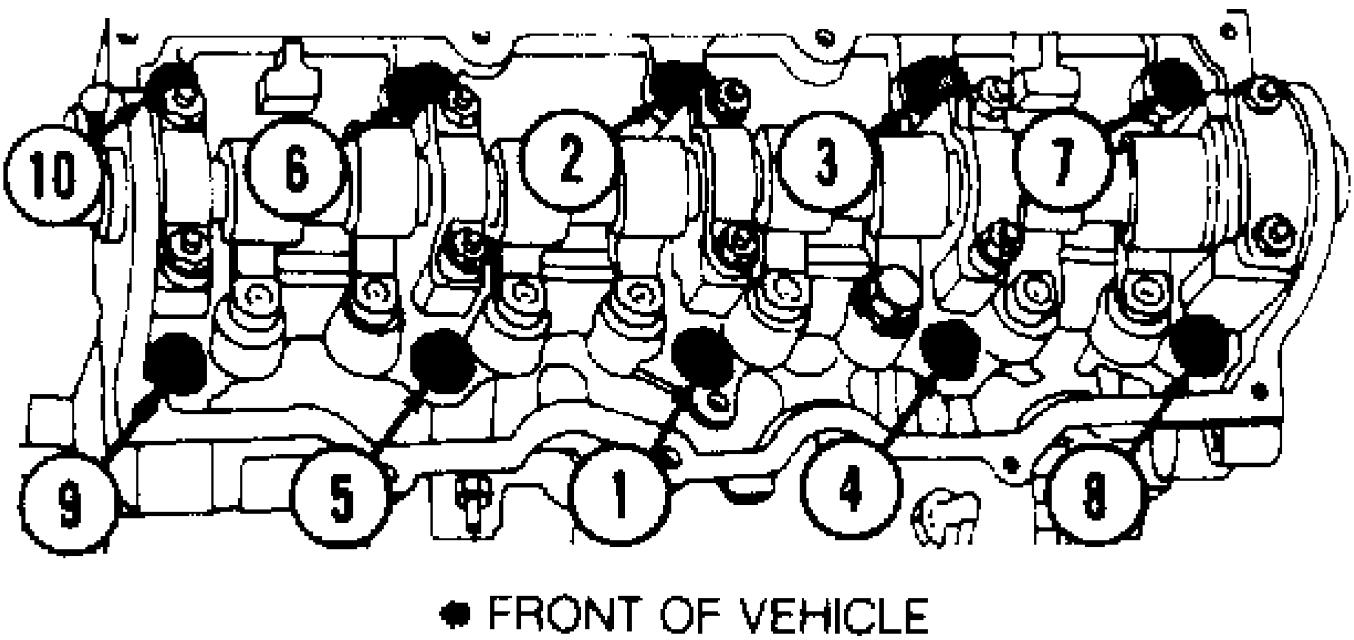

Fig. 1: Typical Cylinder Head Tightening or Loosening Sequence
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INSTALLATION

Ensure all surfaces and head bolts are clean. Check that head bolt holes of cylinder block are clean and dry to prevent block damage when bolts are tightened. Clean threads with tap to ensure accurate bolt torque.

Install head gasket on cylinder block. Some manufacturer's may recommend sealant be applied to head gasket prior to installation. Note that all holes are aligned. Some gasket applications may be marked so certain area faces upward. Install cylinder head using care not to damage head gasket. Ensure cylinder head is fully seated on cylinder block.

Some applications require head bolts be coated with sealant prior to installation. This is done if head bolts are exposed to water passages. Some applications require head bolts be coated with light coat of engine oil.

Install head bolts. Head bolts should be tightened in proper steps and sequence to specification. See Fig. 1. Install remaining components. Tighten all bolts to specification. Adjust valves if required. See VALVE ADJUSTMENT in this article.

NOTE: Some manufacturers require that head bolts be retightened after specified amount of operation. This must be done to prevent head gasket failure.

VALVE ADJUSTMENT

Engine specifications will indicate valve train clearance and temperature at which adjustment is to be made on most models. In most cases, adjustment will be made with a cold engine. In some cases, both a cold and a hot clearance will be given for maintenance convenience.

On some models, adjustment is not required. Rocker arms are tightened to specification and valve lash is automatically set. On some models with push rod actuated valve train, adjustment is made at push rod end of rocker arm while other models do not require adjustment.

Clearance will be checked between tip of rocker arm and tip of valve stem in proper sequence using a feeler gauge. Adjustment is made by rotating adjusting screw until proper clearance is obtained. Lock nut is then tightened. Engine will be rotated to obtain all valve adjustments to manufacturer’s specifications.

Some models require hydraulic lifter to be bled down and clearance measured. Different length push rods can be used to obtain proper clearance. Clearance will be checked between tip of rocker arm and tip of valve stem in proper sequence using a feeler gauge.

On overhead cam engines designed without rocker arms actuate valves directly on a cam follower. A hardened, removable disc is installed between the cam lobe and lifter. Clearance will be checked between cam heel and adjusting disc in proper sequence using a feeler gauge. Engine will be rotated to obtain all valve adjustments.

On overhead cam engines designed with rocker arms, adjustment is made at push rod end of rocker arm. Ensure that the valve to be adjusted is riding on the heel of the cam on all engines. Clearance will be checked between tip of rocker arm and tip of valve stem in proper sequence using a feeler gauge. Adjustment is made by rotating adjusting screw until proper clearance is obtained. Lock nut is then tightened. Engine will be rotated to obtain all valve adjustments to manufacturer’s specifications.

CYLINDER HEAD OVERHAUL

* PLEASE READ THIS FIRST *

NOTE: Always refer to appropriate engine overhaul article in the ENGINES section for complete overhaul procedures and specifications for the vehicle being repaired.

DISASSEMBLY

Mark valves for location. Using valve spring compressor, compress valve springs. Remove valve locks. Carefully release spring compressor. Remove retainer or rotator, valve spring, spring seat and valve. See Fig. 2.

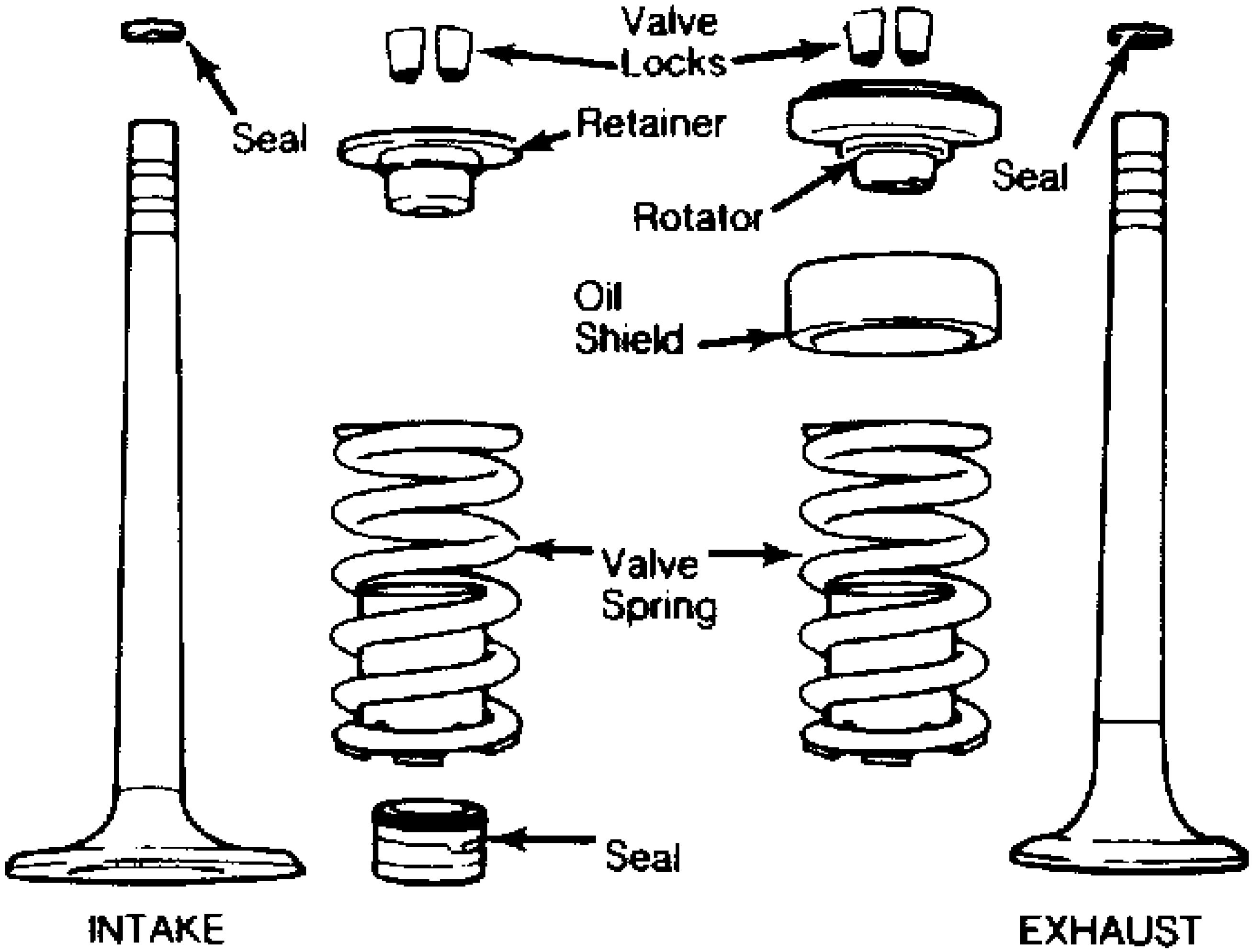

Fig. 2: Exploded View of Intake & Exhaust Valve Assemblies - Typical
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CLEANING & INSPECTION

Clean cylinder head and valve components using approved cleaning methods. Inspect cylinder head for cracks, damage or warped gasket surface. Place straightedge across gasket surface. Determine clearance at center of straightedge. Measure across both diagonals, longitudinal centerline and across the head at several points. See Fig. 3.

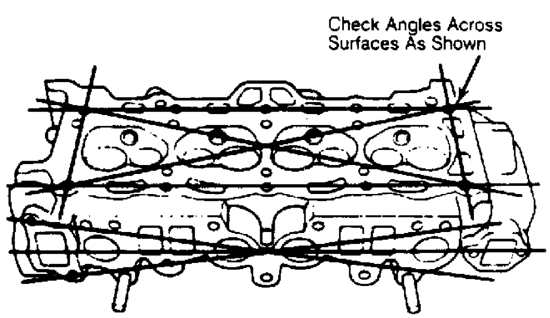

Fig. 3: Checking Cylinder Head for Warpage - Typical
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On cast cylinder heads, if warpage exceeds .003" (.08 mm) in a 6" span, or .006" (.15 mm) over total length, cylinder head must be resurfaced. On most aluminum cylinder heads, if warpage exceeds .002" (.05 mm) in any area, cylinder head must be resurfaced. Warpage specification may vary with manufacturer.

Cylinder head thickness should be measured to determine amount of material which can be removed before replacement is required. Cylinder head thickness must not be less than manufacturer's specifications.

If cylinder head required resurfacing, it may not align properly with intake manifold. On "V" type engines, misalignment is corrected by machining intake manifold surface that contacts cylinder head. Cylinder head may be machined on surface that contacts intake manifold.

Using oil stone, remove burrs or scratches from all sealing surfaces.

VALVE SPRINGS

Inspect valve springs for corroded or pitted valve spring surfaces which may lead to breakage. Polished spring ends caused by a rotating spring, indicates that spring surge has occurred. Replace springs showing evidence of these conditions.

Inspect valve springs for squareness using a 90 degree straightedge. See Fig. 4. Replace valve spring if out-of-square exceeds manufacturer's specification.

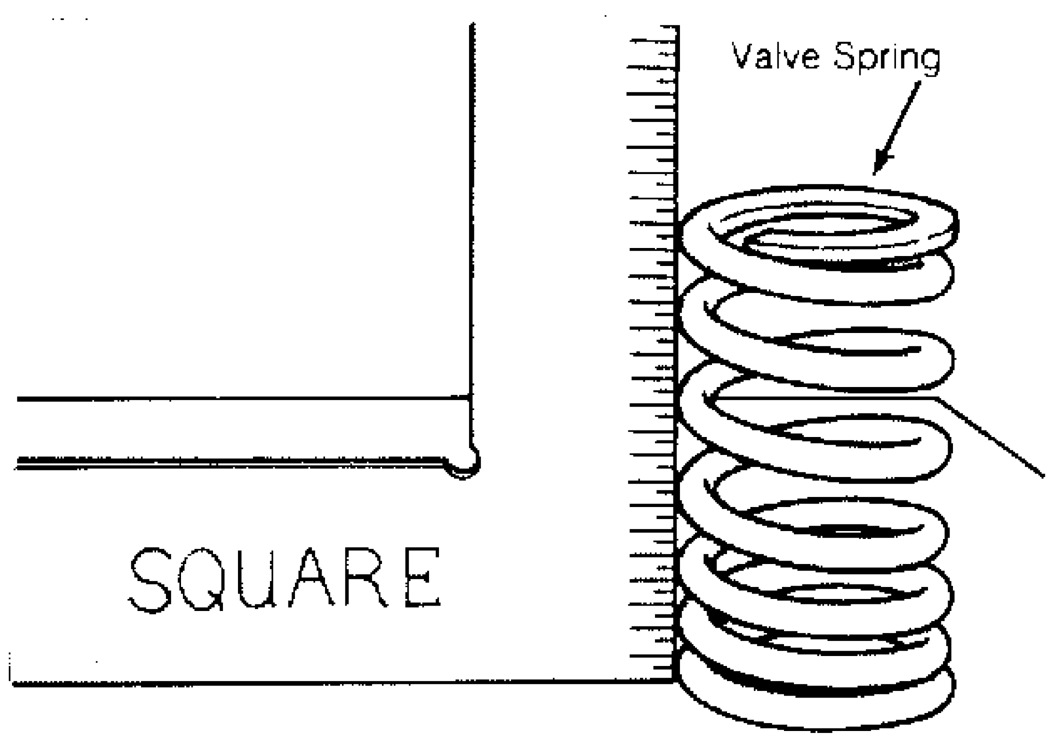

Fig. 4: Checking Valve Spring Squareness - Typical
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Using vernier caliper, measure free length of all valve springs. Replace springs if not within specification. Using valve

spring tester, test valve spring pressure at installed and compressed heights. See Fig. 5.

Usually compressed height is installed height minus valve lift. Replace valve spring if not within specification. It is recommended to replace all valve springs when overhauling cylinder head.

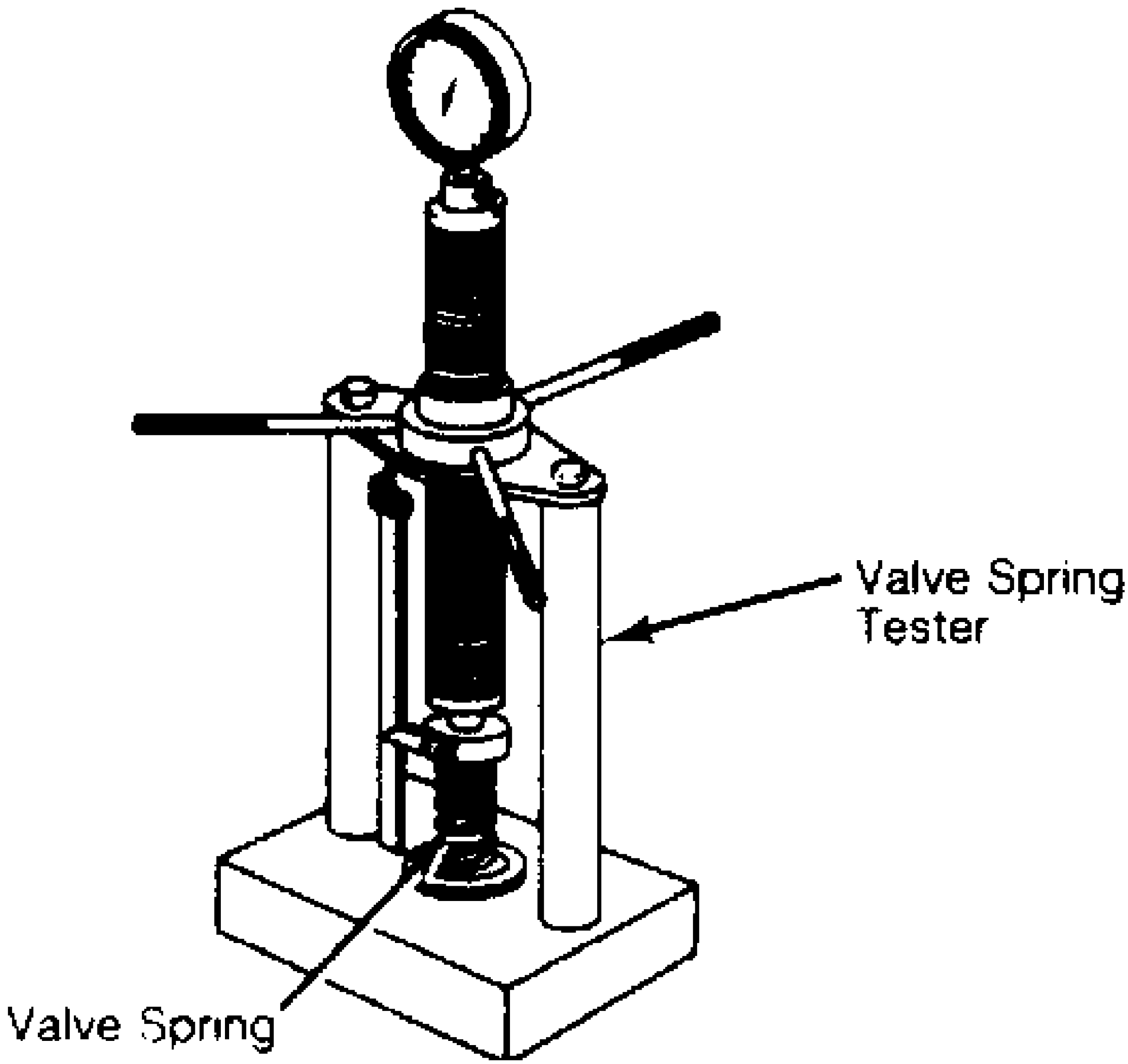

Fig. 5: Checking Valve Spring Pressure - Typical
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VALVE GUIDE

Measuring Valve Guide Clearance

Check valve stem-to-guide clearance. Ensure valve stem diameter is within specifications. Install valve in valve guide. Install dial indicator assembly on cylinder head with tip resting against valve stem just above valve guide. See Fig. 6.

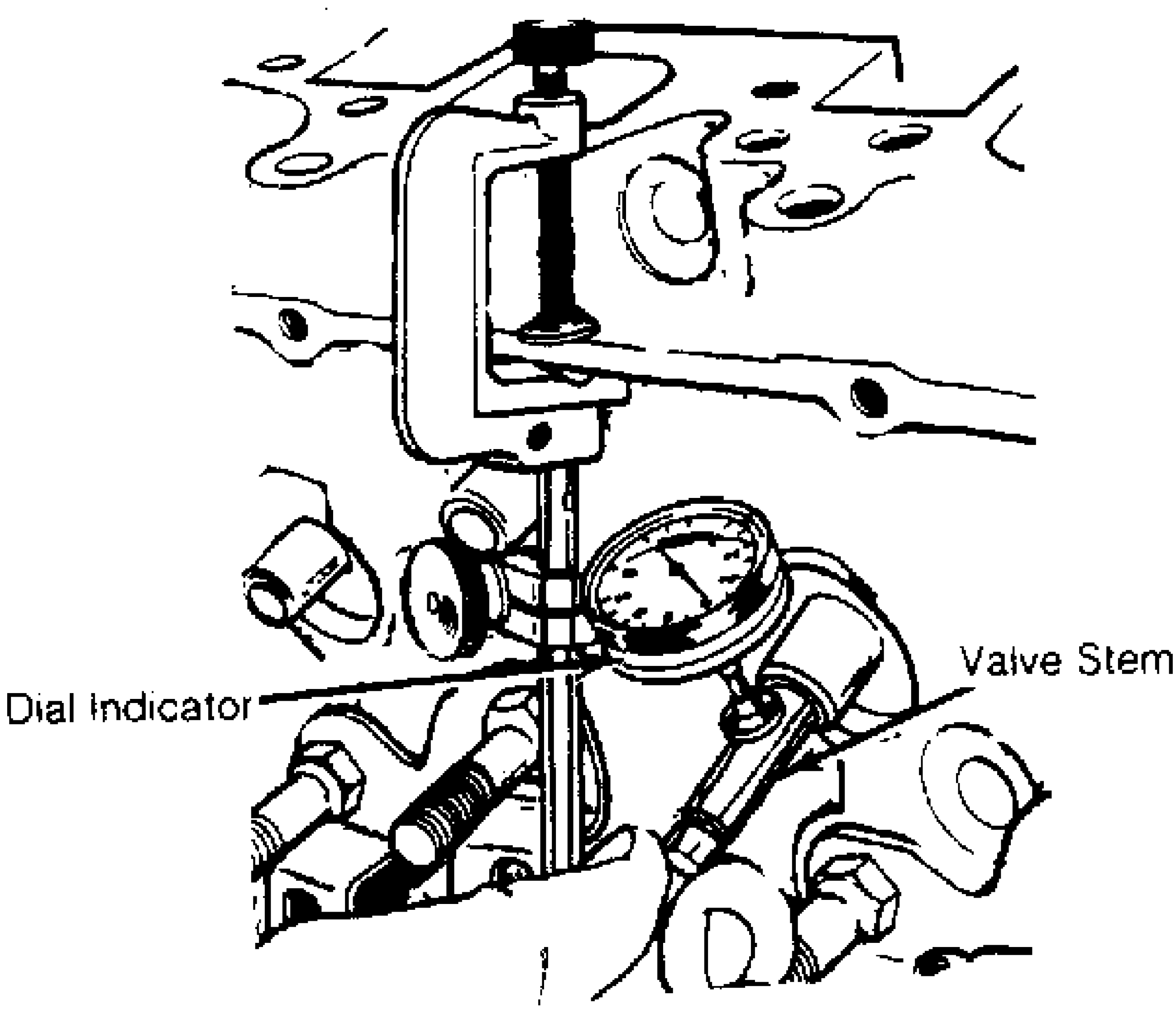

Fig. 6: Measuring Valve Stem-to-Guide Clearance - Typical
This Graphic For General Information Only

Lower valve approximately 1/16" below valve seat. Push valve stem against valve guide as far as possible. Adjust dial indicator to zero. Push valve stem in opposite direction and note reading. Clearance must be within specification.

If valve guide clearance exceeds specification, valves with oversize stems may be used or valve guide must be replaced. On some applications, a false guide is installed, then reamed to proper specification. Valve guide reamer set is used to ream valve guide to obtain proper clearance for new valve.

Reaming Valve Guide

Select proper reamer for valve stem. Reamer must be of proper length to provide clean cut through entire length of valve guide. Install reamer in valve guide and rotate to cut valve guide. See Fig. 7.

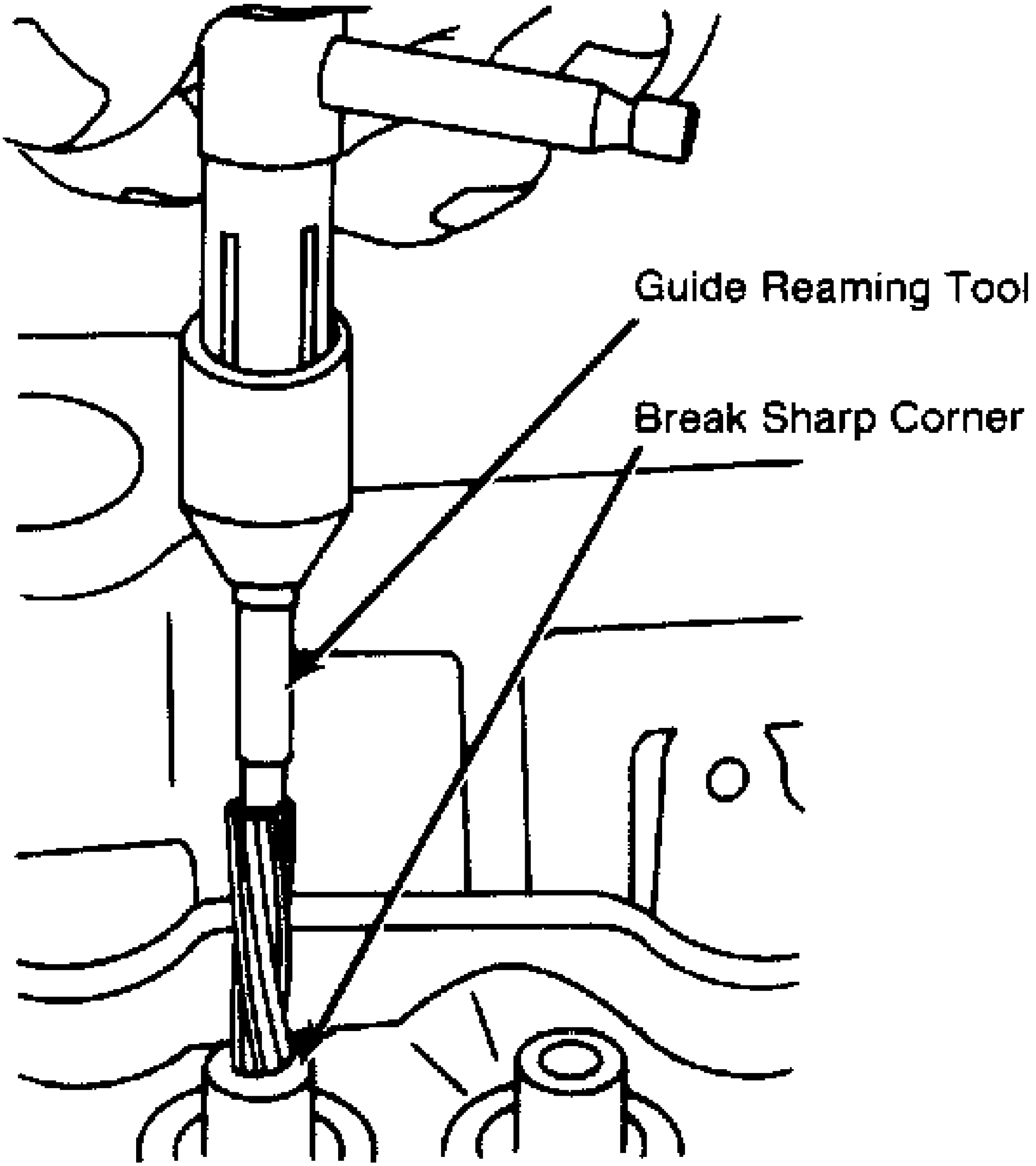

Fig. 7: Reaming Valve Guides - Typical
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Replacing Valve Guide

Replace valve guide if clearance exceeds specification. Valve guides are either pressed, hammered or shrunk in place, depending upon

cylinder head design and type of metal used.

Remove valve guide from cylinder head by pressing or tapping on a stepped drift. See Fig. 8. Once valve guide is installed, distance from cylinder head to top of valve guide must be checked. This distance must be within specification.

Aluminum heads are often heated before installing valve guide. Guide is sometimes chilled in dry ice before installation. Combination of a heated head and chilled guide insures a tight guide fit upon assembly. The new guide must be reamed to specification.

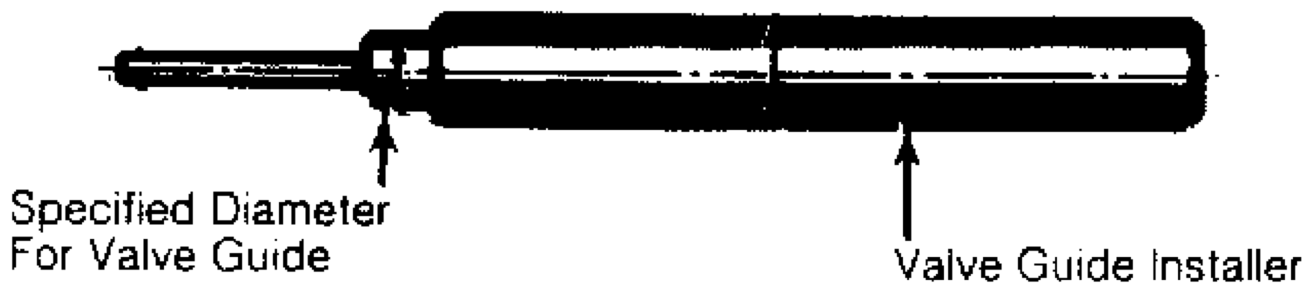

Fig. 8: Typical Valve Guide Remover & Installer
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VALVES & VALVE SEATS

Valve Grinding

Valve stem O.D. should be measured in several areas to indicate amount of wear. Replace valve if not within specification. Valve margin area should be measured to ensure that valve can be grounded. See Fig. 9.

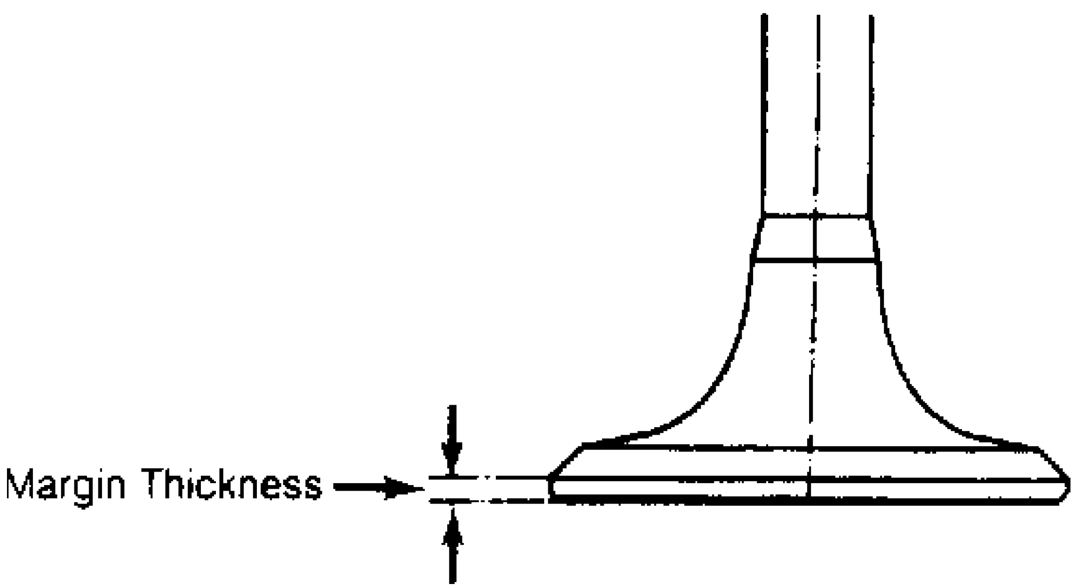

Fig. 9: Measuring Valve Head Margin - Typical
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If valve margin is less than specification, this will burn the valves. Valve must be replaced. Due to minimum margin dimensions

during manufacture, some new type valves cannot be reground.

Resurface valve on proper angle specification using valve grinding machine. Follow manufacturer's instructions for valve grinding machine. Specifications may indicate a different valve face angle than seat angle.

Measure valve margin after grinding. Replace valve if not within specification. Valve stem tip can be refinished using valve grinding machine.

Valve Lapping

During valve lapping of recent designed valves, be sure to follow manufacturers recommendations. Surface hardening and materials used with some valves do not permit lapping. Lapping process will remove excessive amounts of the hardened surface.

Valve lapping is done to ensure adequate sealing between valve face and seat. Use either a hand drill or lapping stick with suction cup attached.

Moisten and attach suction cup to valve. Lubricate valve stem and guide. Apply a thin coat of fine valve grinding compound between valve and seat. Rotate lapping tool between the palms or with hand drill.

Lift valve upward off the seat and change position often. This is done to prevent grooving of valve seat. Lap valve until a smooth polished seat is obtained. Thoroughly clean grinding compound from components. Valve to valve seat concentricity should be checked. See VALVE SEAT CONCENTRICITY.

CAUTION: Valve guides must be in good condition and free of carbon deposits prior to valve seat grinding. Some engines contain an induction hardened valve seat. Excessive material removal will damage valve seats.

Valve Seat Grinding

Select coarse stone of correct size and angle for seat to be ground. Ensure stone is true and has a smooth surface. Select correct size pilot for valve guide dimension. Install pilot in valve guide. Lightly lubricate pilot shaft. Install stone on pilot. Move stone off and on the seat approximately 2 times per second during grinding operation.

Select a fine stone to finish grinding operation. Grinding stones with 30 and 60 degree angles are used to center and narrow the valve seat as required. See Fig. 10.

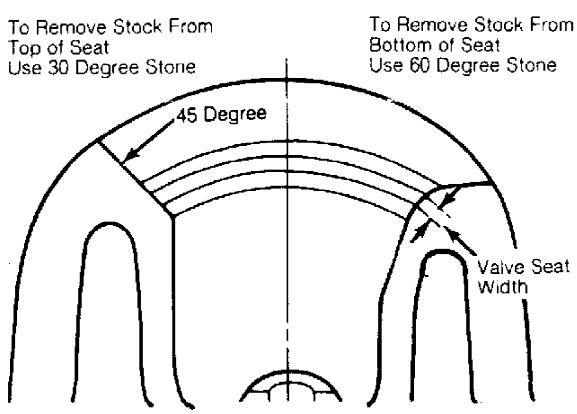

Fig. 10: Adjusting Valve Seat Width - Typical
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Valve Seat Replacement

Replacement of valve seat inserts is done by cutting out

the old insert and machining an oversize insert bore. Replacement oversize insert is usually chilled and the cylinder head is sometimes warmed. Valve seat is pressed into the head. This operation requires specialized machine shop equipment.

Valve Seat Concentricity

Using dial gauge, install gauge pilot in valve guide. Position gauge arm on the valve seat. Adjust dial indicator to zero. Rotate arm 360 degrees and note reading. Runout should not exceed specification.

To check valve-to-valve seat concentricity, coat valve face lightly with Prussian Blue dye. Install valve and rotate it on valve seat. If pattern is even and entire seat is coated at valve contact point, valve is concentric with the seat.

REASSEMBLY

Valve Stem Installed Height

Valve stem installed height must be checked when new valves are installed or when valves or valve seats have been ground. Install valve in valve guide. Measure distance from tip of valve stem to spring seat. See Fig. 11. Distance must be within specifications.

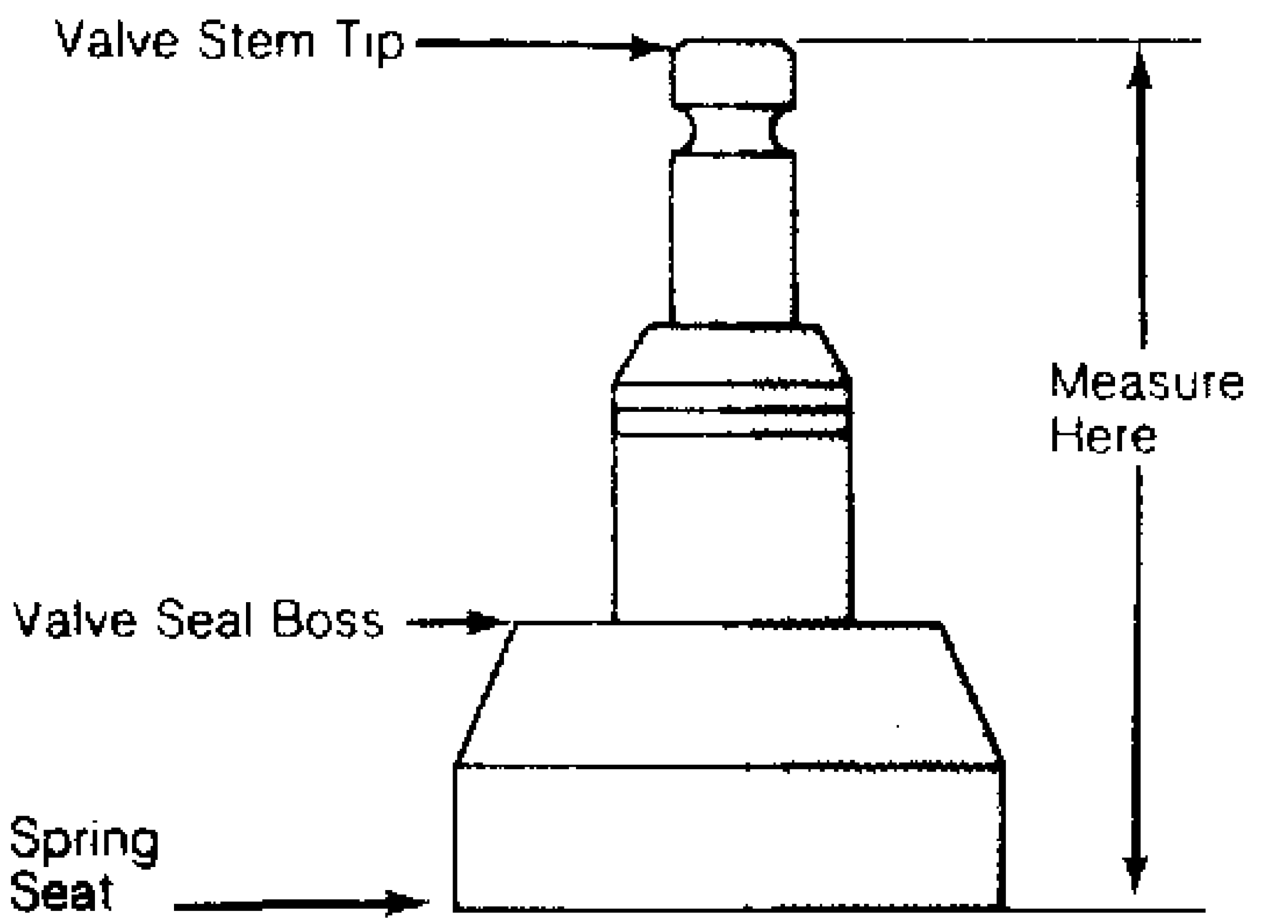

Fig. 11: Measuring Valve Stem Installed Height - Typical
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Remove valve and grind valve stem tip if height exceeds specification. Valve tips are surface hardened. DO NOT remove more

than .010" (.25 mm) from tip. Chamfer sharp edge of reground valve tip. Recheck valve stem installed height.

VALVE STEM OIL SEALS

Valve stem oil seals must be installed on valve stem. See Fig. 2. Seals are needed due to pressure differential at the ends of valve guides. Atmospheric pressure above intake guide, combined with manifold vacuum below guide, causes oil to be drawn into the cylinder.

Exhaust guides also have pressure differential created by exhaust gas flowing past the guide, creating a low pressure area. This low pressure area draws oil into the exhaust system.

Replacement (On Vehicle)

Mark rocker arm or overhead cam components for location. Remove rocker arm components or overhead cam components. Components must be installed in original location. Remove spark plugs. Valve stem oil seals may be replaced by holding valves against seats using air pressure.

Air pressure must be installed in cylinder using an adapter for spark plug hole. An adapter can be constructed by welding air hose connection to spark plug body with porcelain removed.

Install adapter in spark plug hole. Apply a minimum of 140 psi (9.8 kg/cm^2) to adapter. Air pressure should hold valve closed. If air pressure does not hold valve closed, check for damaged or bent valve. Cylinder head must be removed for service.

Using valve spring compressor, compress valve springs. Remove valve locks. Carefully release spring compressor. Remove retainer or rotator and valve spring. Remove valve stem oil seal.

If oversized valves have been installed, oversized oil seals must be used. Coat valve stem with engine oil. Install protective sleeve over end of valve stem. Install new oil seal over valve stem and seat on valve guide. Remove protective sleeve. Install spring seat, valve spring and retainer or rotator. Compress spring and install valve locks. Remove spring compressor. Ensure valve locks are fully seated.

Install rocker arms or overhead cam components. Tighten all bolts to specification. Adjust valves if required. Remove adapter. Install spark plugs, valve cover and gasket.

VALVE SPRING INSTALLED HEIGHT

Valve spring installed height should be checked during reassembly. Measure height from lower edge of valve spring to the upper edge. DO NOT include valve spring seat or retainer. Distance must be within specifications. If valves and/or seats have been ground, a valve spring shim may be required to correct spring height. See Fig. 12.

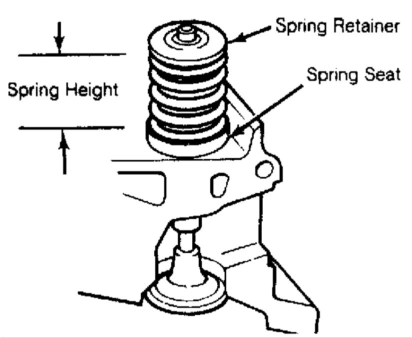

Fig. 12: Measuring Valve Spring Installed Height - Typical
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ROCKER ARMS & ASSEMBLIES

Rocker Studs

Rocker studs are either threaded or pressed in place. Threaded studs are removed by locking 2 nuts on the stud. Unscrew the stud by turning the jam nut. Coat the stud threads with Loctite and install. Tighten to specification.

Pressed in stud can be removed using a stud puller. Ream the stud bore to proper specification and press in a new oversize stud. Pressed in studs are often replaced by cutting threads in the stud bore to accept a threaded stud.

Rocker Arms & Shafts

Mark rocker arms for location. Remove rocker arm retaining bolts. Remove rocker arms. Inspect rocker arms, shafts, bushings and pivot balls (if equipped) for excessive wear. Inspect rocker arms for wear in valve stem contact area. Measure rocker arm bushing I.D. Replace bushings if excessively worn.

The rocker arm valve stem contact point can be reground, using special fixture for valve grinding machine. Remove minimum amount of material as possible. Ensure all oil passages are clear. Install rocker arms in original locations. Ensure rocker arm is properly seated in push rod. Tighten bolts to specification. Adjust valves if required. See VALVE ADJUSTMENT in this article.

Pushrods

Remove rocker arms. Mark push rods for location. Remove push rods. Push rods can be steel or aluminum, solid or hollow. Hollow pushrods must be internally cleaned to ensure oil passage to the rocker arms is cleaned. Check the pushrod for damage, such as loose ends on steel tipped aluminum types.

Check push rod for straightness. Roll push rod on a flat surface. Using feeler gauge, check clearance at center. Replace push rod if bent. The push rod can also be supported at each end and rotated. A dial indicator is used to detect bends in the push rod.

Lubricate ends of push rod and install push rod in original location. Ensure push rod is properly seated in lifter. Install rocker arm. Tighten bolts to specification. Adjust valves if required. See VALVE ADJUSTMENT in this article.

LIFTERS

Hydraulic Lifters

Before replacing a hydraulic lifter for noisy operation, ensure noise is not caused by worn rocker arms or valve tips. Hydraulic lifter assemblies must be installed in original locations. Remove the rocker arm assembly and push rod. Mark components for location. Some applications require intake manifold, or lifter cover removal. Remove lifter retainer plate (if used). To remove lifters, use a hydraulic lifter remover or magnet. Different type lifters are used. See Fig. 13.

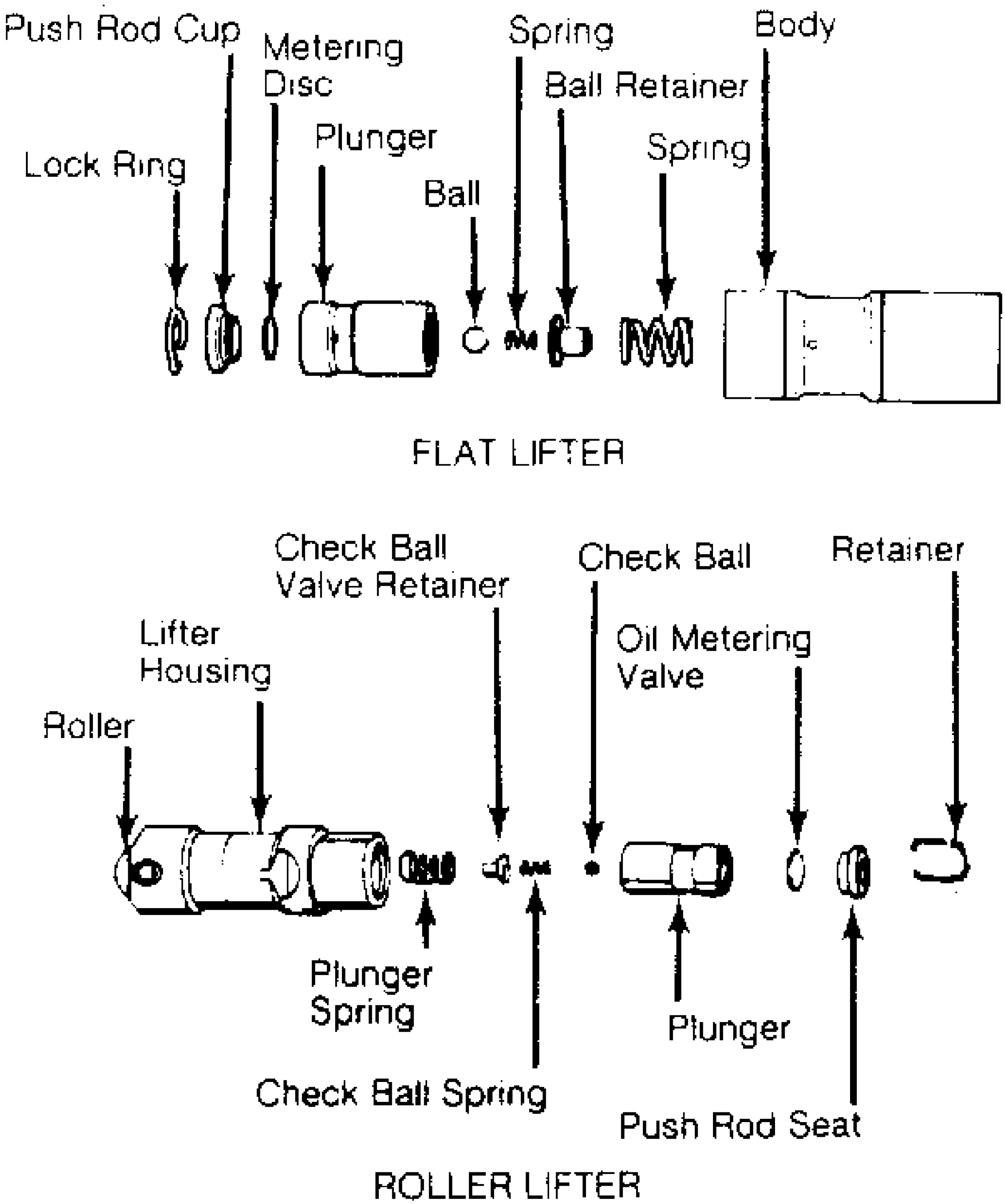

Fig. 13: Typical Hydraulic Valve Lifter Assemblies - Typical
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On sticking lifters, disassemble and clean lifter. DO NOT mix lifter components or positions. Parts are select-fitted and are not

interchangeable. Inspect all components for wear. Note amount of wear in lifter body-to-camshaft contact area. Surface must have smooth and convex contact face. If wear is apparent, carefully inspect cam lobe.

Inspect push rod contact area and lifter body for scoring or signs of wear. If body is scored, inspect lifter bore for damage and lack of lubrication. On roller type lifters, inspect roller for flaking, pitting, loss of needle bearings and roughness during rotation.

Measure lifter body O.D. in several areas. Measure lifter bore I.D. of cylinder block. Some models offer oversized lifters. Replace lifter if damaged.

If lifter check valve is not operating, obstructions may be preventing it from closing or valve spring may be broken. Clean or replace components as necessary.

Check plunger operation. Plunger should drop to bottom of the body by its own weight when assembled dry. If plunger is not free, soak lifter in solvent to dissolve deposits.

Lifter leak-down test can be performed on lifter. Lifter must be filled with special test oil. New lifters contain special test oil. Using lifter leak-down tester, perform leak-down test following manufacturer's instructions. If leak-down time is not within specifications, replace lifter assembly.

Lifters should be soaked in clean engine oil several hours prior to installation. Coat lifter base, roller (if equipped) and lifter body with ample amount of Molykote or camshaft lubricant. See Fig. 13. Install lifter in original location. Install remaining components. Valve lash adjustment is not required on most hydraulic lifters. Preload of hydraulic lifter is automatic. Some models may require adjustment.

Mechanical Lifters

Lifter assemblies must be installed in original locations. Remove rocker arm assembly and push rod. Mark components for location. Some applications require intake manifold or lifter cover removal. Remove lifter retainer plate (if used). To remove lifters, use lifter remover or magnet.

Inspect push rod contact area and lifter body for scoring or signs of wear. If body is scored, inspect lifter bore for damage and lack of lubrication. Note amount of wear in lifter body-to-camshaft contact area. Surface must have smooth and convex contact face. If wear is apparent, carefully inspect cam lobe.

Coat lifter base, roller (if equipped) and lifter body with ample amount of Molykote or camshaft lubricant. Install lifter in original location. Install remaining components. Tighten bolts to specification. Adjust valves. See VALVE ADJUSTMENT in this article.

PISTONS, CONNECTING RODS & BEARINGS

* PLEASE READ THIS FIRST *

NOTE: Always refer to appropriate engine overhaul article in the ENGINES section for complete overhaul procedures and specifications for the vehicle being repaired.

RIDGE REMOVAL

Ridge in cylinder wall must be removed prior to piston removal. Failure to remove ridge prior to removing pistons will cause piston damage in piston ring locations.

With the piston at bottom dead center, place a rag in the bore to trap metal chips. Install ridge reamer in cylinder bore. Adjust ridge reamer using manufacturer's instructions. Remove ridge

using ridge reamer. DO NOT remove an excessive amount of material. Ensure ridge is completely removed.

PISTON & CONNECTING ROD REMOVAL

Note top of piston. Some pistons may contain a notch, arrow or be marked "FRONT". Piston must be installed in proper direction to prevent damage with valve operation.

Check that connecting rod and cap are numbered for cylinder location and which side of cylinder block the number faces. Proper cap and connecting rod must be installed together. Connecting rod cap must be installed on connecting rod in proper direction to ensure bearing lock procedure. Mark connecting rod and cap if necessary. Pistons must be installed in original location.

Remove cap retaining nuts or bolts. Remove bearing cap. Install stud protectors on connecting rod bolts. This protects cylinder walls from scoring during removal. Ensure proper removal of ridge. Push piston and connecting rod from cylinder. Connecting rod boss can be tapped with a wooden dowel or hammer handle to aid in removal.

PISTON & CONNECTING ROD

Disassembly

Using ring expander, remove piston rings. Remove piston pin retaining rings (if equipped). On pressed type piston pins, special fixtures and procedures according to manufacturer must be used to remove piston pins. Follow manufacturer's recommendations to avoid piston distortion or breakage.

Cleaning

Remove all carbon and varnish from piston. Pistons and connecting rods may be cleaned in cold type chemical tank. Using ring groove cleaner, clean all deposits from ring grooves. Ensure all deposits are cleaned from ring grooves to prevent ring breakage or sticking. DO NOT attempt to clean pistons using wire brush.

Inspection

Inspect pistons for nicks, scoring, cracks or damage in ring areas. Connecting rod should be checked for cracks using Magnaflux procedure. Piston diameter must be measured in manufacturers specified area.

Using telescopic gauge and micrometer, measure piston pin bore of piston in 2 areas, 90 degrees apart. This is done to check diameter and out-of-round.

Install proper bearing cap on connecting rod. Ensure bearing cap is installed in proper location. Tighten bolts or nuts to specification. Using inside micrometer, measure inside diameter in 2 areas, 90 degrees apart.

Connecting rod I.D. and out-of-round must be within specification. Measure piston pin bore I.D. and piston pin O.D. All components must be within specification. Subtract piston pin diameter from piston pin bore in piston and connecting rod to determine proper fit.

Connecting rod length must be measured from center of crankshaft journal inside diameter to center of piston pin bushing using proper caliper. Connecting rods must be the same length. Connecting rods should be checked on an alignment fixture for bent or twisted condition. Replace all components which are damaged or not within specification.

PISTON & CYLINDER BORE FIT

Ensure cylinder is checked for taper, out-of-round and properly honed prior to checking piston and cylinder bore fit. See CYLINDER BLOCK in this article. Using dial bore gauge, measure cylinder bore. Measure piston at right angle to piston pin in center of piston skirt area. Subtract piston diameter from cylinder bore diameter. The difference is piston-to-cylinder clearance. Clearance must be within specification. Mark piston for proper cylinder location.

ASSEMBLING PISTON & CONNECTING ROD

Install proper fitted piston on connecting rod for proper cylinder. Ensure piston marking on top of piston marked is in correspondence with connecting rod and cap number. See Fig. 14.

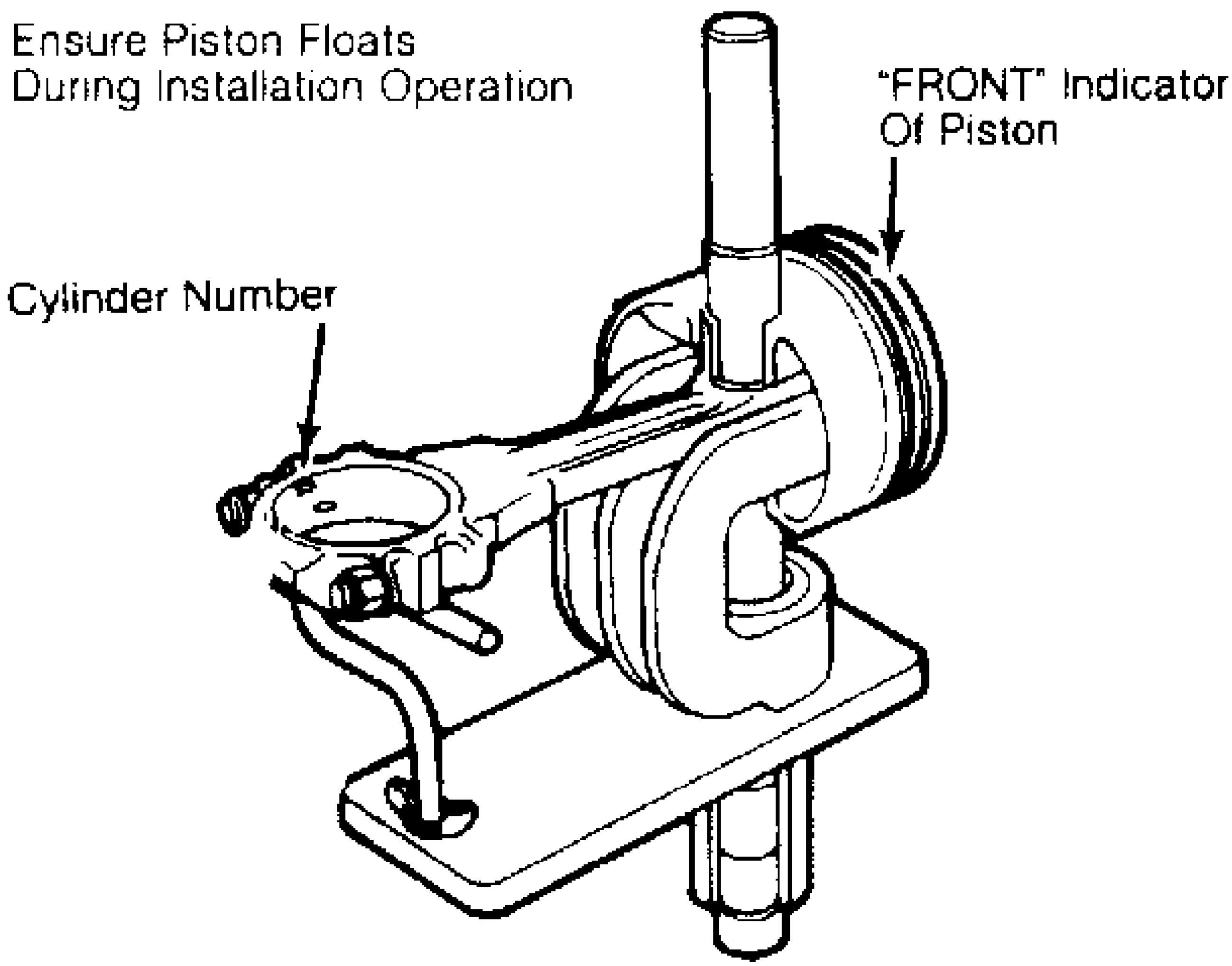

Fig. 14: Piston Pin Installation - Typical
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Lubricate piston pin and install in connecting rod. Ensure piston pin retainers are fully seated (if equipped). On pressed type piston pins, follow manufacturer's recommended procedure to avoid distortion or breakage.

CHECKING PISTON RING CLEARANCES

Piston rings must be checked for side clearance and end gap. To check end gap, install piston ring in cylinder which it is to be installed. Using an inverted piston, push ring to bottom of cylinder in smallest cylinder diameter.

Using feeler gauge, check ring end gap. See Fig. 15. Piston ring end gap must be within specification. Ring breakage will occur with insufficient ring end gap.

On some manufacturers, insufficient ring end gap may be corrected by using a fine file while other manufacturers recommend using another ring set. Mark rings for proper cylinder installation after checking end gap.

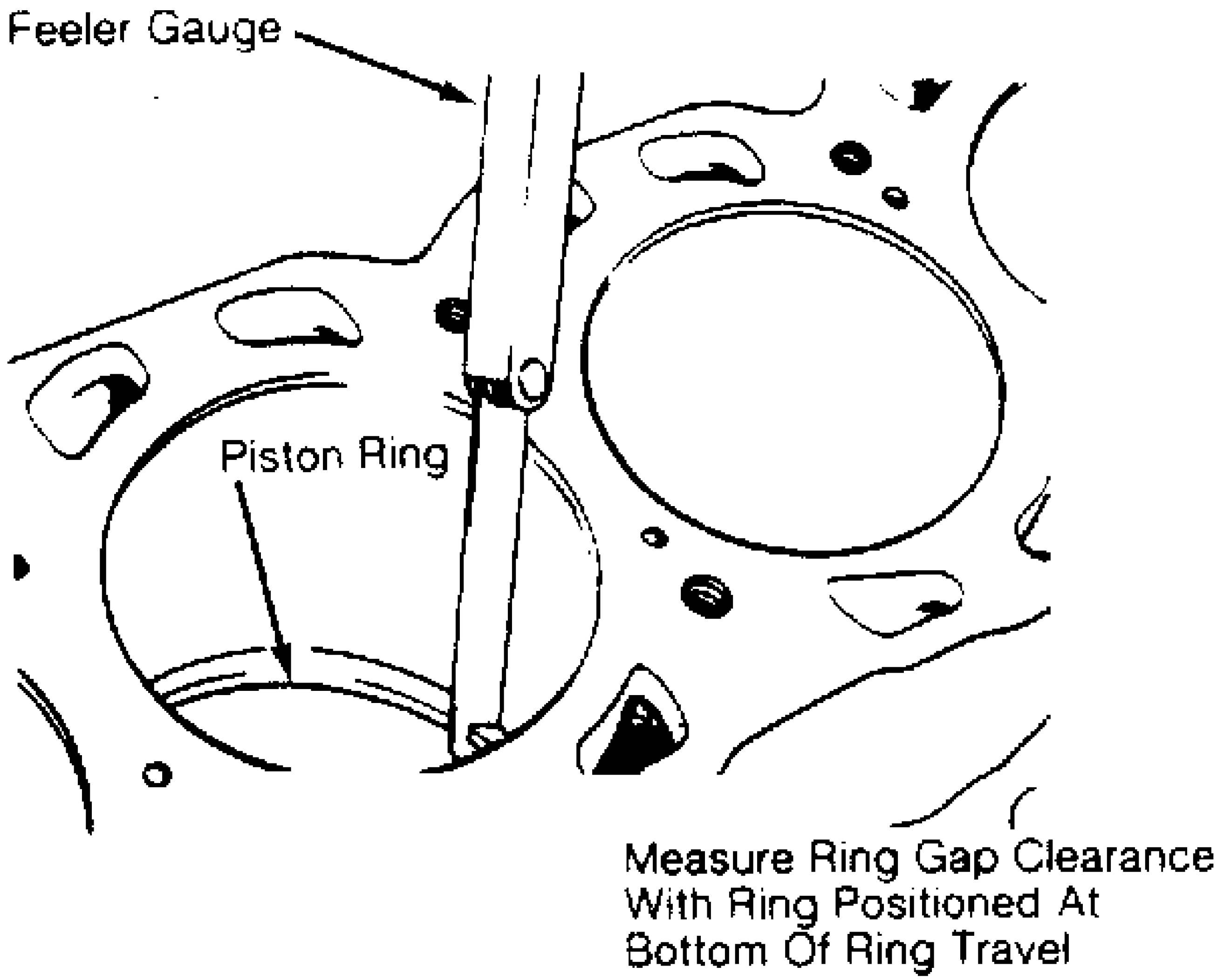

Fig. 15: Checking Piston Ring End Gap - Typical
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For checking side clearance, install rings on piston. Using feeler gauge, measure clearance between piston ring and piston ring land. Check side clearance in several areas around piston. Side clearance must be within specification.

If side clearance is excessive, piston ring grooves can be machined to accept oversized piston rings (if available). Normal practice is to replace piston.

PISTON & CONNECTING ROD INSTALLATION

Cylinders must be honed prior to piston installation. See CYLINDER HONING under CYLINDER BLOCK in this article.

Install upper connecting rod bearings. Lubricate upper bearings with engine oil. Install lower bearings in rod caps. Ensure bearing tabs are properly seated. Position piston ring gaps according to manufacturers recommendations. See Fig. 16. Lubricate pistons, rings and cylinder walls.

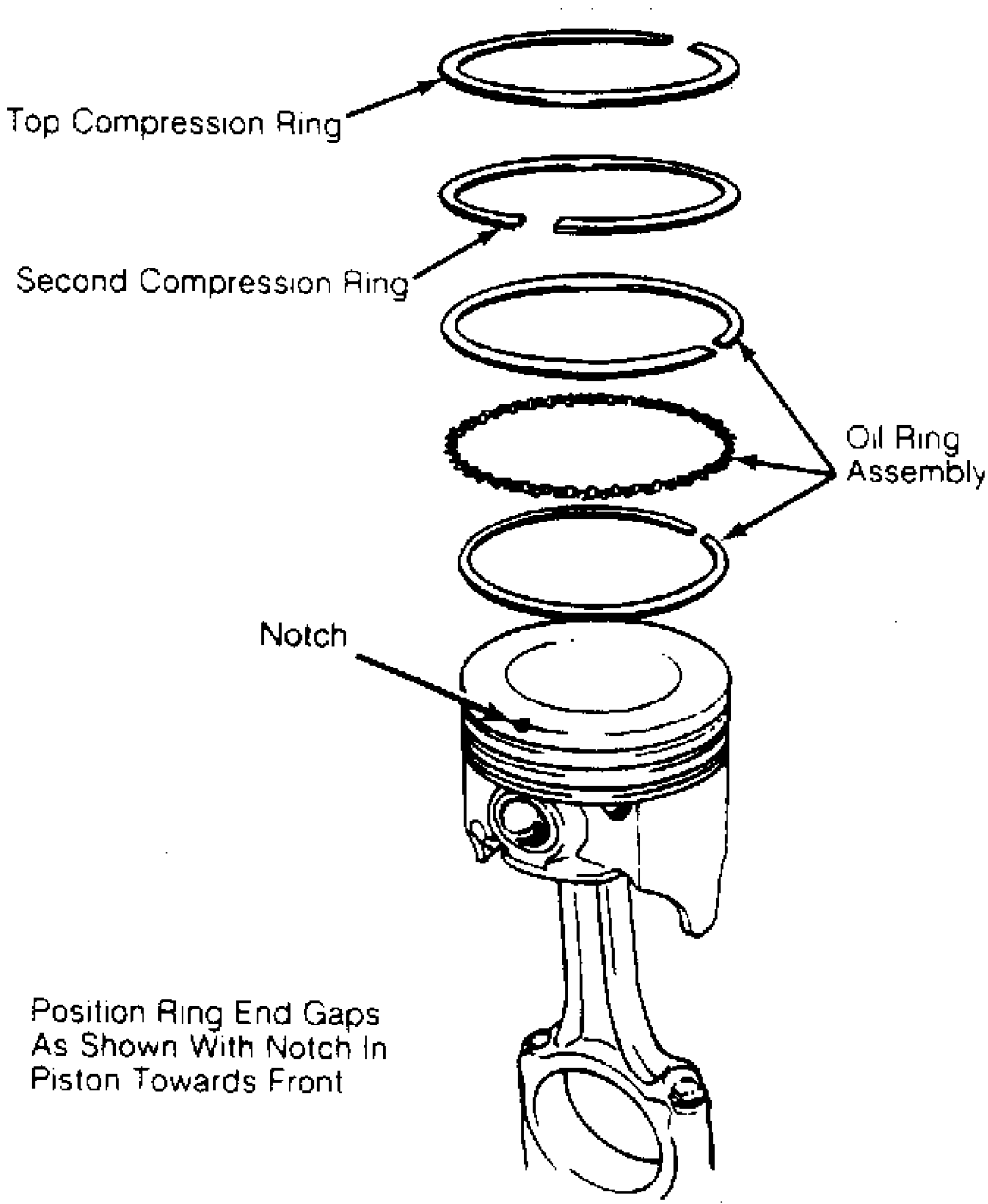

Fig. 16: Typical Piston Ring End Gap Positioning - Typical
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Install ring compressor. Use care not to rotate piston rings. Compress rings with ring compressor. Install plastic tubing protectors

over connecting rod bolts. Install piston and connecting rod assembly. Ensure piston notch, arrow or "FRONT" mark is toward front of engine. See Fig. 17.

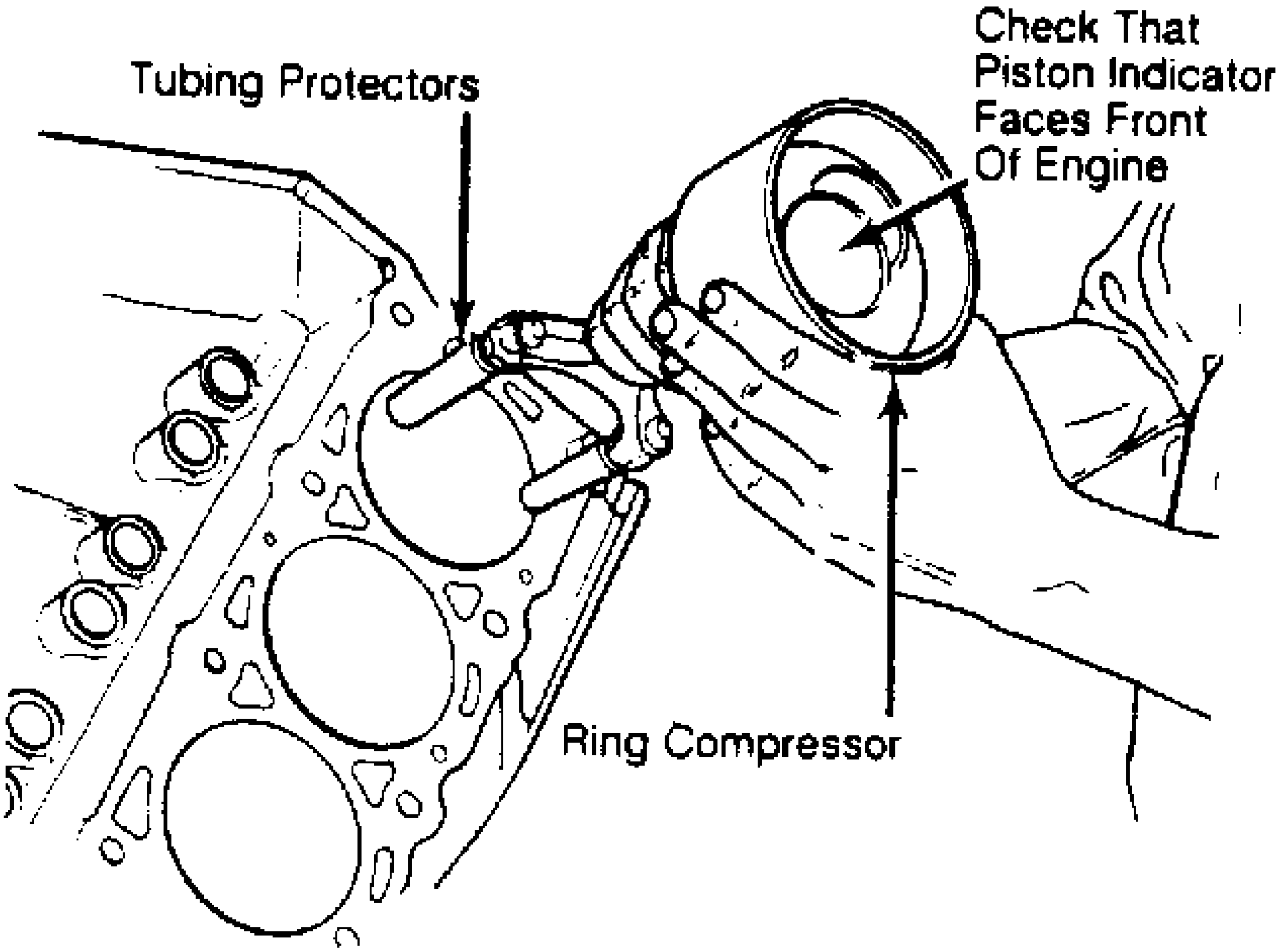

Fig. 17: Installing Piston & Connecting Rod Assembly - Typical
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Carefully tap piston into cylinder until rod bearing is seated on crankshaft journal. Remove protectors. Install rod cap and bearing. Lightly tighten connecting rod bolts. Repeat procedure for remaining cylinders. Check bearing clearance. See MAIN & CONNECTING ROD BEARING CLEARANCE in this article.

Once clearance is checked, lubricate journals and bearings. Install bearing caps. Ensure marks are aligned on connecting rod and cap. Tighten rod nuts or bolts to specification. Ensure rod moves freely on crankshaft. Check connecting rod side clearance. See CONNECTING ROD SIDE CLEARANCE in this article.

CONNECTING ROD SIDE CLEARANCE

Position connecting rod toward one side of crankshaft as far as possible. Using feeler gauge, measure clearance between side of connecting rod and crankshaft. See Fig. 18. Clearance must be within specifications.

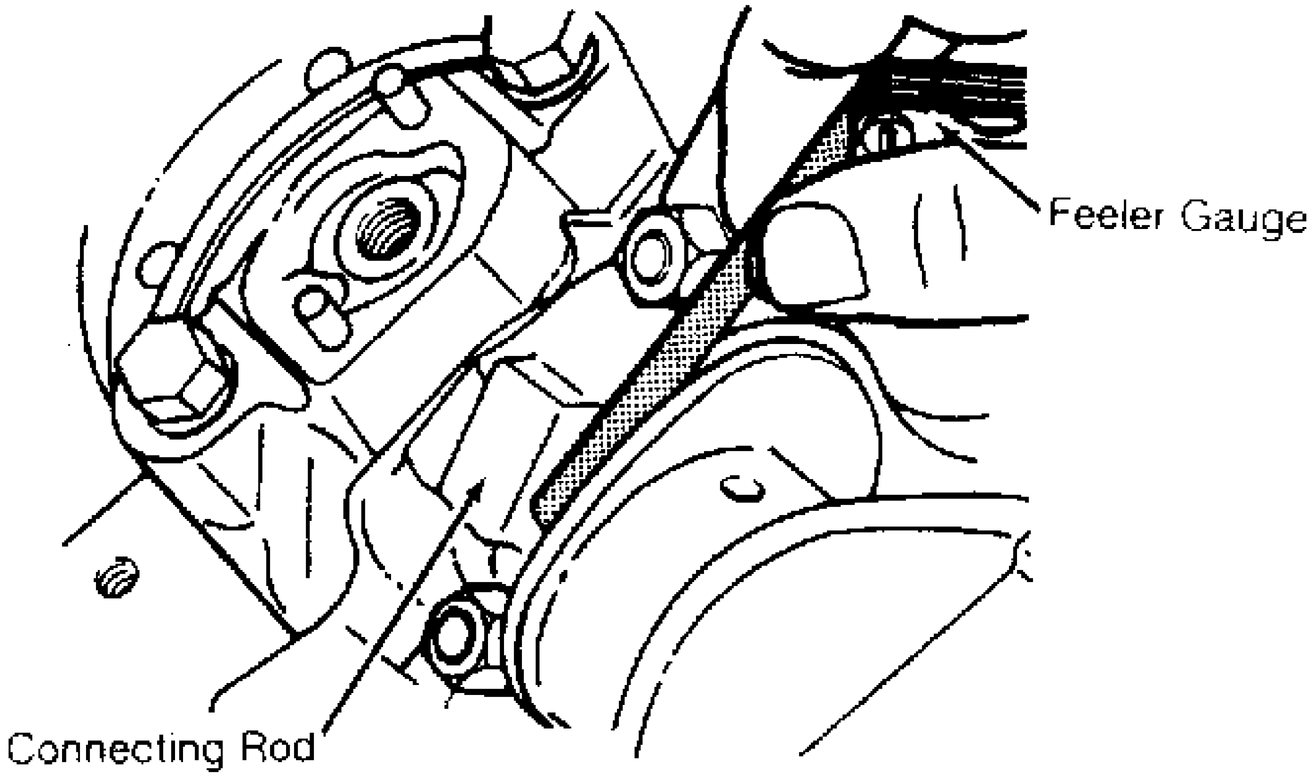

Fig. 18: Measuring Connecting Rod Side Clearance - Typical
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Check for improper bearing installation, wrong bearing cap or insufficient bearing clearance if side clearance is insufficient. Connecting rod may require machining to obtain proper clearance. Excessive clearance usually indicates excessive wear at crankshaft. Crankshaft must be repaired or replaced.

MAIN & CONNECTING ROD BEARING CLEARANCE

Plastigage Method

Plastigage method may be used to determine bearing clearance. Plastigage can be used with an engine in service or during reassembly. Plastigage material is oil soluble.

Ensure journals and bearings are free of oil or solvent. Oil or solvent will dissolve material and false reading will be obtained. Install small piece of Plastigage along full length of bearing journal. Install bearing cap in original location. Tighten bolts to specification.

CAUTION: DO NOT rotate crankshaft while Plastigage is installed. Bearing clearance will not be obtained if crankshaft is rotated.

Remove bearing cap. Compare Plastigage width with scale on Plastigage container to determine bearing clearance. See Fig. 19. Rotate crankshaft 90 degrees. Repeat procedure. this is done to check journal eccentricity. This procedure can be used to check oil clearance on both connecting rod and main bearings.

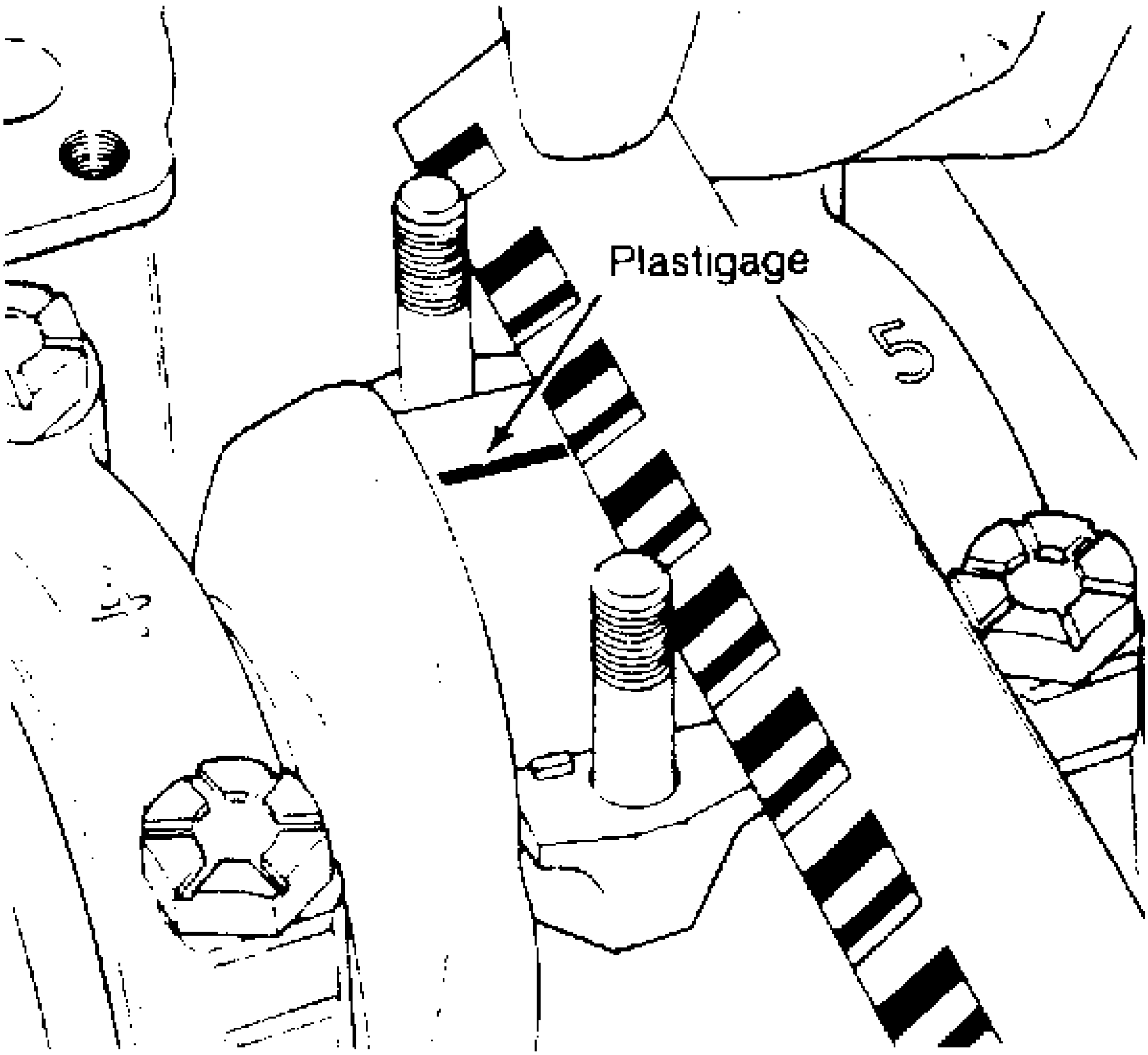

Fig. 19: Measuring Bearing Clearance - Typical
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Micrometer & Telescopic Gauge Method

A micrometer is used to determine journal diameter, taper and out-of-round dimensions of the crankshaft. See CLEANING & INSPECTION under CRANKSHAFT & MAIN BEARINGS in this article.

With crankshaft removed, install bearings and caps in original location on cylinder block. Tighten bolts to specification. On connecting rods, install bearings and caps on connecting rods. Install proper connecting rod cap on corresponding rod. Ensure bearing cap is installed in original location. Tighten bolts to specification.

Using a telescopic gauge and micrometer or inside micrometer measure inside diameter of connecting rod and main bearings bores. Subtract each crankshaft journal diameter from the corresponding inside bore diameter. This is the bearing clearance.

CRANKSHAFT & MAIN BEARINGS

* PLEASE READ THIS FIRST *

NOTE: Always refer to appropriate engine overhaul article in the ENGINES section for complete overhaul procedures and specifications for the vehicle being repaired.

REMOVAL

Ensure all main bearing caps are marked for location on cylinder block. Some main bearing caps have an arrow stamped on it which must face front of engine. Remove main bearing cap bolts. Remove main bearing caps. Carefully remove crankshaft. Use care not to bind crankshaft in cylinder block during removal.

CLEANING & INSPECTION

Thoroughly clean crankshaft using solvent. Dry with compressed air. Ensure all oil passages are clear and free of sludge, rust, dirt, and metal chips.

Inspect crankshaft for scoring and nicks. Inspect crankshaft for cracks using Magnaflux procedure. Inspect rear seal area for grooving or damage. Inspect bolt hole threads for damage. If pilot bearing or bushing is used, check pilot bearing or bushing fit in crankshaft. Inspect crankshaft gear for damaged or cracked teeth. Replace gear if damaged. Check that oil passage plugs are tight (if equipped).

Using micrometer, measure all journals in 4 areas to determine journal taper, out-of-round and undersize. See Fig. 20. Some crankshafts can be reground to the next largest undersize, depending on the amount of wear or damage. Crankshafts with rolled fillet cannot be reground and must be replaced.

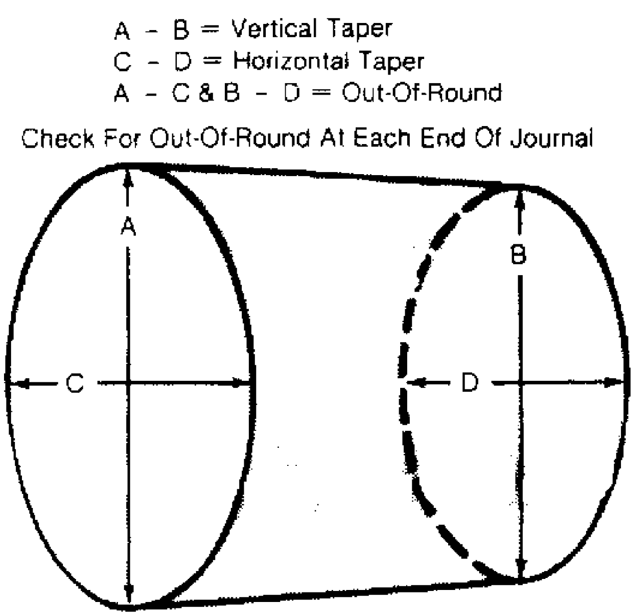

Fig. 20: Measuring Crankshaft Journal - Typical
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Crankshaft journal runout should be checked. Install crankshaft in "V" blocks or bench center. Position dial indicator

with tip resting on the main bearing journal area. See Fig. 21. Rotate crankshaft and note reading. Journal runout must not exceed specification. Repeat procedure on all main bearing journals. Crankshaft must be replaced if runout exceeds specification.

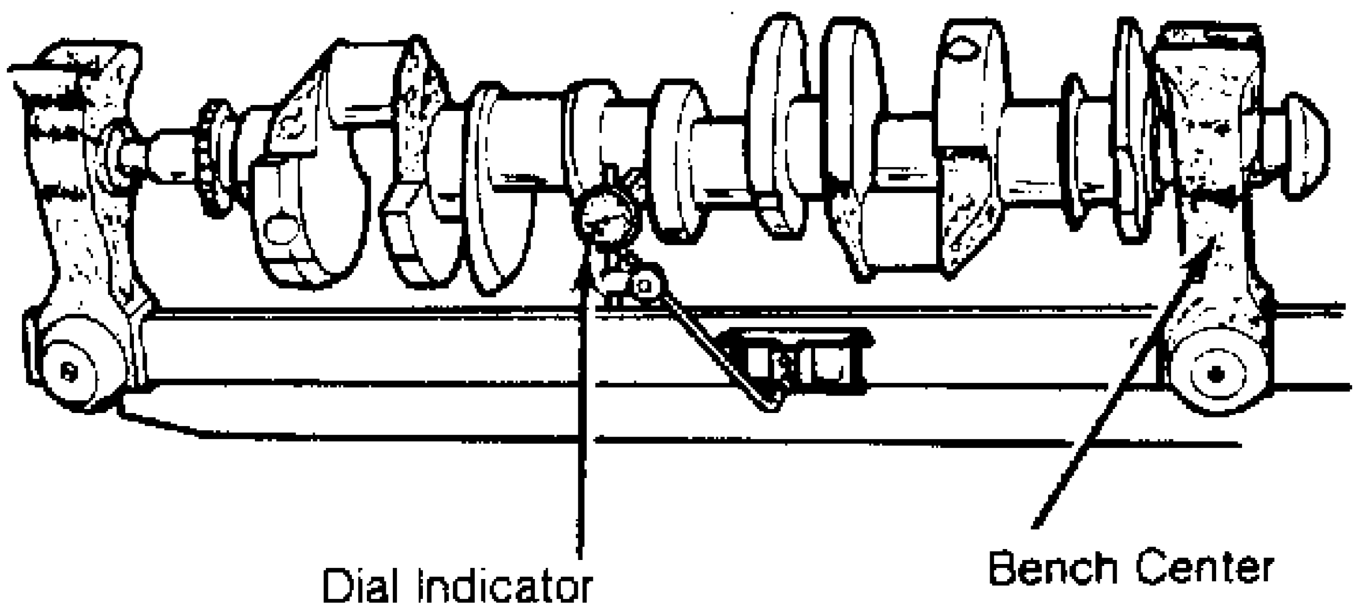

Fig. 21: Measuring Crankshaft Main Bearing Journal Runout - Typical
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INSTALLATION

Install upper main bearing in cylinder block. Ensure lock tab is properly located in cylinder block. Install bearings in main bearing caps. Ensure all oil passages are aligned. Install rear seal (if removed).

Ensure crankshaft journals are clean. Lubricate upper main bearings with clean engine oil. Carefully install crankshaft. Check each main bearing clearance using Plastigage method. See MAIN & CONNECTING ROD BEARING CLEARANCE in this article.

Once clearance is checked, lubricate lower main bearing and journals. Install main bearing caps in original location. Install rear seal in rear main bearing cap (if removed). Some rear main bearing caps require sealant to be applied in corners to prevent oil leakage.

Install and tighten all bolts except thrust bearing cap to specification. Tighten thrust bearing cap bolts finger tight only. Thrust bearing must be aligned. On most applications, crankshaft must be moved rearward then forward. Procedure may vary with manufacturer. Thrust bearing cap is then tighten to specification. Ensure crankshaft rotates freely. Crankshaft end play should be checked. See CRANKSHAFT END PLAY in this article.

CRANKSHAFT END PLAY

Dial Indicator Method

Crankshaft end play can be checked using dial indicator. Mount dial indicator on rear of cylinder block. Position dial indicator tip against rear of crankshaft. Ensure tip is resting against flat surface.

Pry crankshaft rearward. Adjust dial indicator to zero.

Pry crankshaft forward and note reading. Crankshaft end play must be within specification. If end play is not within specification, check for faulty thrust bearing installation or worn crankshaft. Some applications offer oversized thrust bearings.

Feeler Gauge Method

Crankshaft end play can be checked using feeler gauge. Pry crankshaft rearward. Pry crankshaft forward. Using feeler gauge, measure clearance between crankshaft and thrust bearing surface. See Fig. 22.

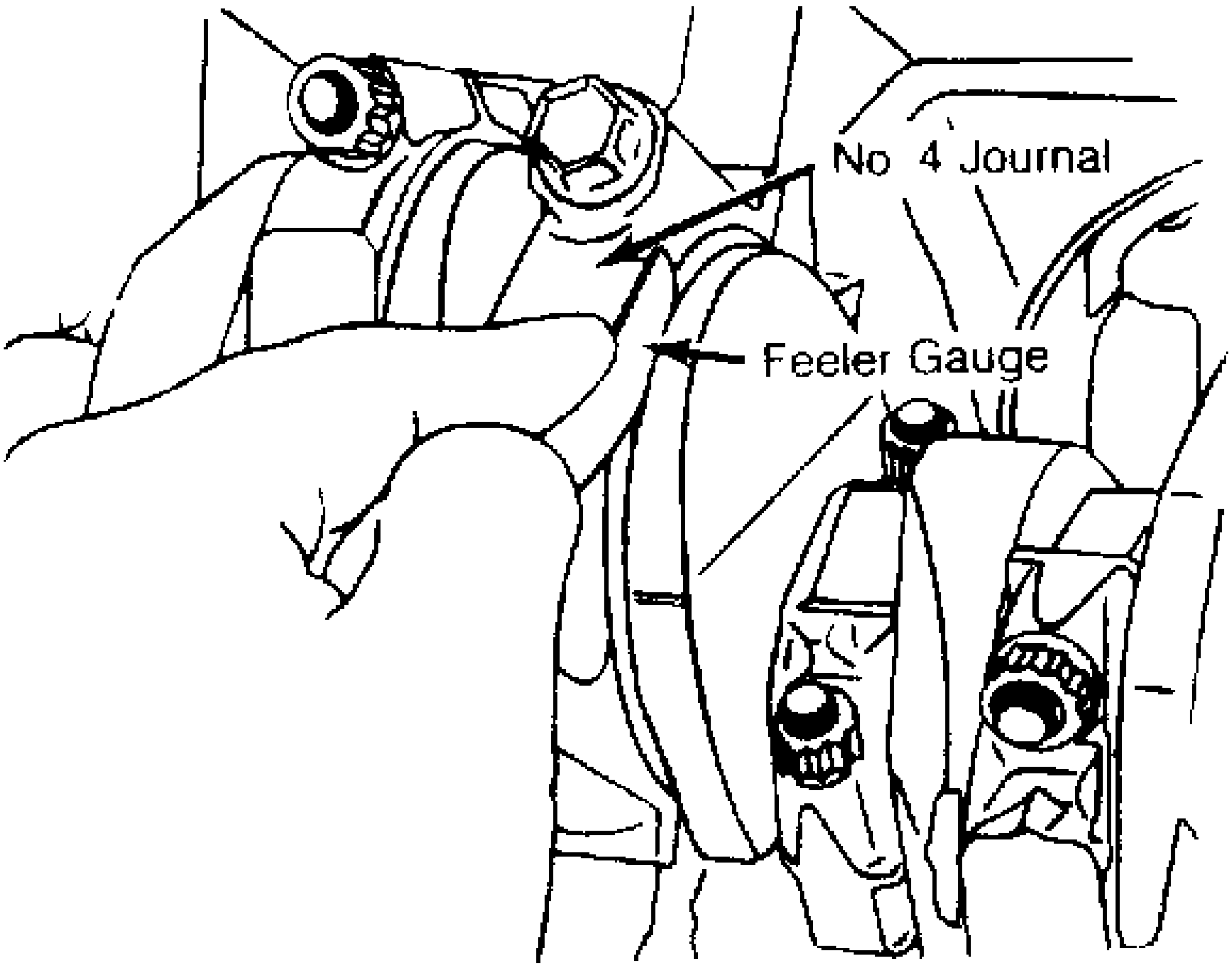

Fig. 22: Checking Crankshaft End Play - Typical
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Crankshaft end play must be within specification. If end play is not within specification, check for faulty thrust bearing installation or worn crankshaft. Some applications offer oversized thrust bearings.

CYLINDER BLOCK

* PLEASE READ THIS FIRST *

NOTE: Always refer to appropriate engine overhaul article in the ENGINES section for complete overhaul procedures and specifications for the vehicle being repaired.

BLOCK CLEANING

Only cast cylinder blocks should be hot tank cleaned. Aluminum cylinder blocks should be cleaned using cold tank method. Cylinder block is cleaned in order to remove carbon deposits, gasket residue and water jacket scale. Remove oil galley plugs, freeze plugs and cam bearings prior to block cleaning.

BLOCK INSPECTION

Visually inspect the block. Check suspected areas for cracks using the Dye Penetrant inspection method. Block may be checked for cracks using the Magnaflux method.

Cracks are most commonly found at the bottom of the cylinders, the main bearing saddles, near expansion plugs and between the cylinders and water jackets. Inspect lifter bores for damage. Inspect all head bolt holes for damaged threads. Threads should be cleaned using tap to ensure proper head bolt torque. Consult machine shop concerning possible welding and machining (if required).

CYLINDER BORE INSPECTION

Inspect the bore for scuffing or roughness. Cylinder bore is dimensionally checked for out-of-round and taper using dial bore gauge. For determining out-of-round, measure cylinder parallel and perpendicular to the block centerline. Difference in the 2 readings is the bore out-of-round. Cylinder bore must be checked at top, middle and bottom of piston travel area.

Bore taper is obtained by measuring bore at the top and bottom. If wear has exceeded allowable limits, block must be honed or bored to next available oversize piston dimension.

CYLINDER HONING

Cylinder must be properly honed to allow new piston rings to properly seat. Cross-hatching at correct angle and depth is critical to lubrication of cylinder walls and pistons.

A flexible drive hone and power drill are commonly used. Drive hone must be lubricated during operation. Mix equal parts of kerosene and SAE 20w engine oil for lubrication.

Apply lubrication to cylinder wall. Operate cylinder hone from top to bottom of cylinder using even strokes to produce 45 degree cross-hatch pattern on the cylinder wall. DO NOT allow cylinder hone to extend below cylinder during operation.

Recheck bore dimension after final honing. Wash cylinder wall with hot soapy water to remove abrasive particles. Blow dry with compressed air. Coat cleaned cylinder walls with lubricating oil.

DECK WARPAGE

Check deck for damage or warped head sealing surface. Place a straightedge across gasket surface of the deck. Using feeler gauge, measure clearance at center of straightedge. Measure across width and

length of cylinder block at several points.

If warpage exceeds specifications, deck must be resurfaced. If warpage exceeds manufacturer's maximum tolerance for material removal, replace block.

DECK HEIGHT

Distance from the crankshaft centerline to the block deck is termed the deck height. Measure and record front and rear main journals of crankshaft. To compute this distance, install crankshaft and retain with center main bearing and cap only. Measure distance from the crankshaft journal to the block deck, parallel to the cylinder centerline.

Add one half of the main bearing journal diameter to distance from crankshaft journal to block deck. This dimension should be checked at front and rear of cylinder block. Both readings should be the same.

If difference exceeds specifications, cylinder block must be repaired or replaced. Deck height and warpage should be corrected at the same time.

MAIN BEARING BORE & ALIGNMENT

For checking main bearing bore, remove all bearings from cylinder block and main bearing caps. Install main bearing caps in original location. Tighten bolts to specification. Using inside micrometer, measure main bearing bore in 2 areas 90 degrees apart. Determine bore size and out-of-round. If diameter is not within specification, block must be align-bored.

For checking alignment, place a straightedge along centerline of main bearing saddles. Check for clearance between straightedge and main bearing saddles. Block must be align-bored if clearance is present.

EXPANSION PLUG REMOVAL & INSTALLATION

Removal

Drill a hole in the center of expansion plug. Remove with screwdriver or punch. Use care not to damage sealing surface.

Installation

Ensure sealing surface is free of burrs. Coat expansion plug with sealer. Use a wooden dowel or pipe of slightly smaller diameter, install expansion plug. Ensure expansion plug is evenly located.

OIL GALLERY PLUG REMOVAL & INSTALLATION

Removal

Remove threaded oil gallery plugs using the appropriate wrench. Soft, press-in plugs are removed by drilling into plug and installing a sheet metal screw. Remove plug with slide hammer or pliers.

Installation

Ensure threads or sealing surface is clean. Coat threaded oil gallery plugs with sealer and install. Replacement soft press-in plugs are driven in place with a hammer and drift.

CAMSHAFT

* PLEASE READ THIS FIRST *

NOTE: Always refer to appropriate engine overhaul article in the ENGINES section for complete overhaul procedures and specifications for the vehicle being repaired.

CLEANING & INSPECTION

Clean camshaft with solvent. Ensure all oil passages are clear. Inspect cam lobes and bearing journals for pitting, flaking or scoring. Using micrometer, measure bearing journal O.D.

Support camshaft at each end with "V" blocks. Position dial indicator with tip resting on center bearing journal. Rotate camshaft and note reading. If reading exceeds specification, replace camshaft.

Check cam lobe lift by measuring base circle of camshaft using micrometer. Measure again at 90 degrees to tip of cam lobe. Cam lift can be determined by subtracting base circle diameter from tip of cam lobe measurement.

Different lift dimensions are given for intake and exhaust cam lobes. Reading must be within specifications. Replace camshaft if cam lobes or bearing journals are not within specifications.

Inspect camshaft gear for chipped, eroded or damaged teeth. Replace gear if damaged. On camshafts using thrust plate, measure distance between thrust plate and camshaft shoulder. Replace thrust plate if not within specification.

CAMSHAFT BEARINGS

Removal & Installation

Remove the camshaft rear plug. The camshaft bearing remover is assembled with its shoulder resting on the bearing to be removed according to manufacturer's instructions. Tighten puller nut until bearing is removed. Remove remaining bearings, leaving front and rear bearings until last. These bearings act as guide for camshaft bearing remover.

To install new bearings, puller is rearranged to pull bearings toward the center of block. Ensure all lubrication passages of bearing are aligned with cylinder block. Coat new camshaft rear plug with sealant. Install camshaft rear plug. Ensure plug is even in cylinder block.

CAMSHAFT INSTALLATION

Lubricate bearing surfaces and cam lobes with ample amount of Molykote or camshaft lubricant. Carefully install camshaft. Use care not to damage bearing journals during installation. Install thrust plate retaining bolts (if equipped). Tighten bolts to specification. On overhead camshafts, install bearing caps in original location. Tighten bolts to specification. Check end play.

CAMSHAFT END PLAY

Using dial indicator, check end play. Position dial indicator on front of engine block. Position indicator tip against camshaft. Push camshaft toward rear of engine and adjust indicator to zero.

Move camshaft forward and note reading. Camshaft end play must be within specification. End play may be adjusted by relocating gear, shimming thrust plate or replacing thrust plate depending on manufacturer.

TIMING CHAINS & BELTS

* PLEASE READ THIS FIRST *

NOTE: Always refer to appropriate engine overhaul article in the ENGINES section for complete overhaul procedures and specifications for the vehicle being repaired.

TIMING CHAINS

Timing chains will stretch during operation. Limits are placed upon amount of stretch before replacement is required. Timing chain stretch will alter ignition timing and valve timing.

To check timing chain stretch, rotate crankshaft to eliminate slack from one side of timing chain. Mark reference point on cylinder block. Rotate crankshaft in opposite direction to eliminate slack from remaining side of timing chain. Force other side of chain outward and measure distance between reference point and timing chain. See Fig. 23. Replace timing chain and gears if not within specification.

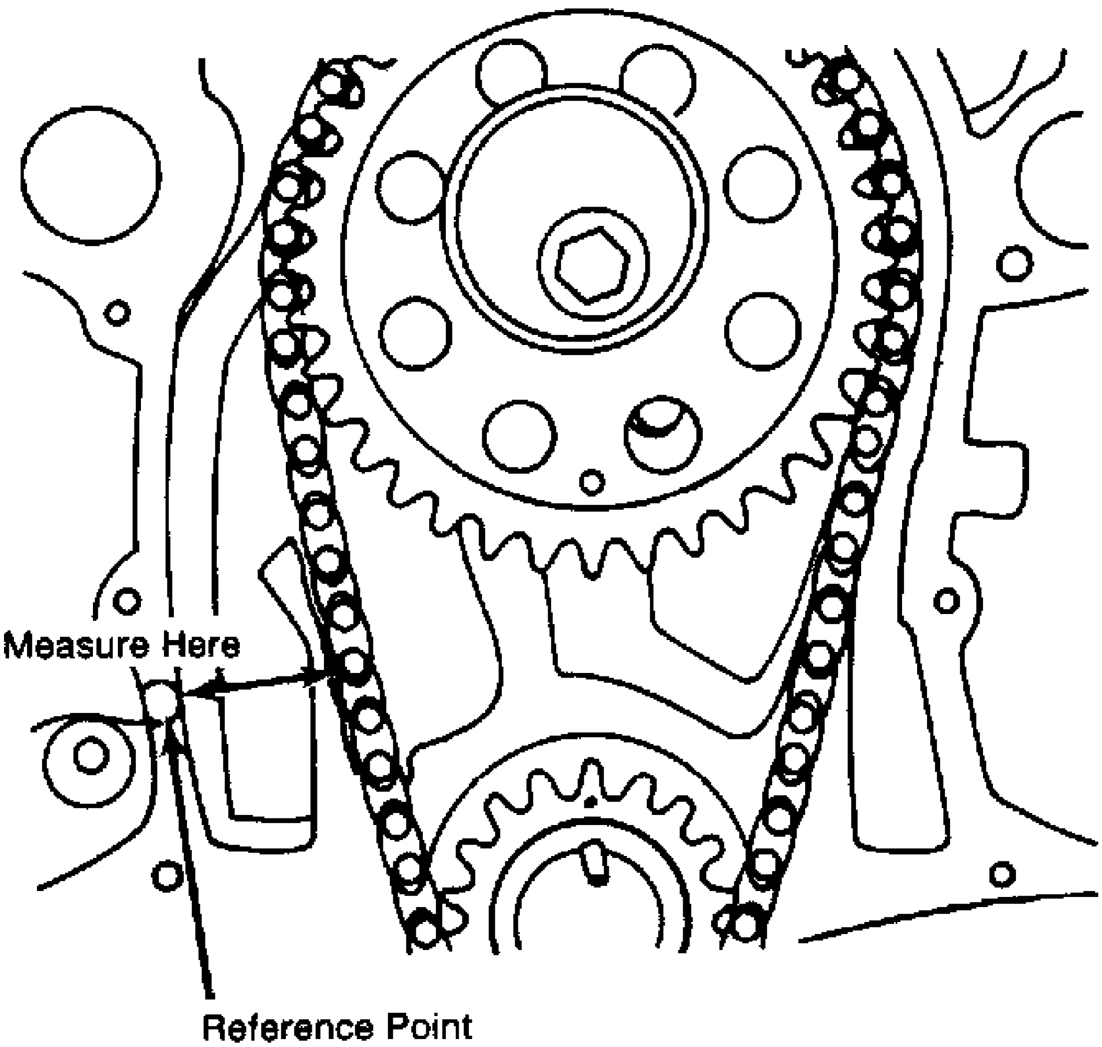

Fig. 23: Measuring Timing Chain Stretch - Typical
This Graphic For General Information Only

Timing chains must be installed so that timing marks on camshaft gear and crankshaft gear are aligned according to

manufacturer. See Fig. 24.

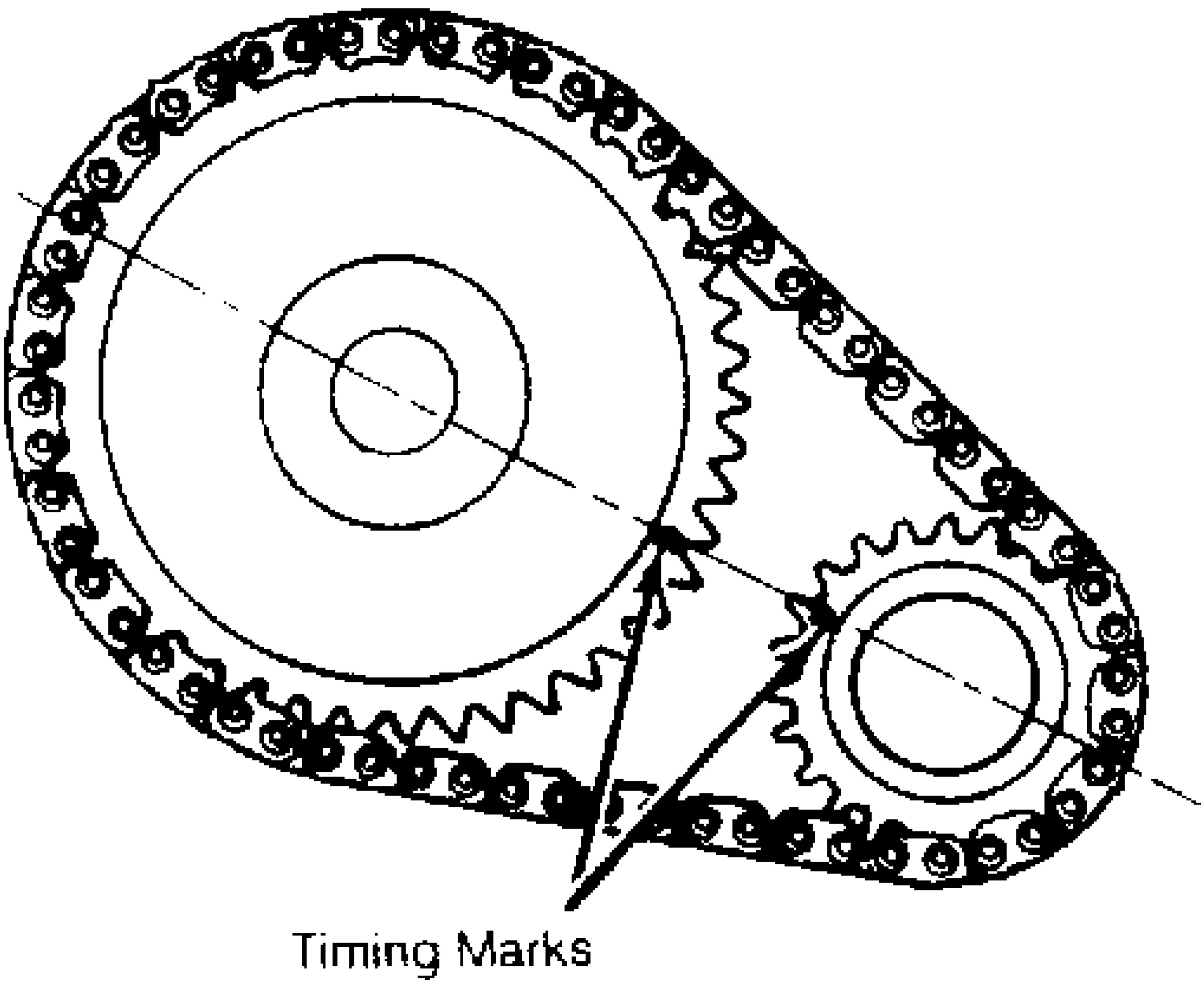

Fig. 24: Timing Gear Mark Alignment - Typical
This Graphic For General Information Only

TIMING BELTS

Cogged tooth belts are commonly used on overhead cam engines. Inspect belt teeth for rounded corners or cracking. Replace belt if cracked, damaged, missing teeth or oil soaked.

Used timing belt must be installed in original direction of rotation. Inspect all sprocket teeth for wear. Replace all worn sprockets. Sprockets are marked for timing purposes. Engine is positioned so that crankshaft sprocket mark will be upward. Camshaft sprocket is aligned with reference mark on cylinder head and timing belt is installed. See Fig. 25.

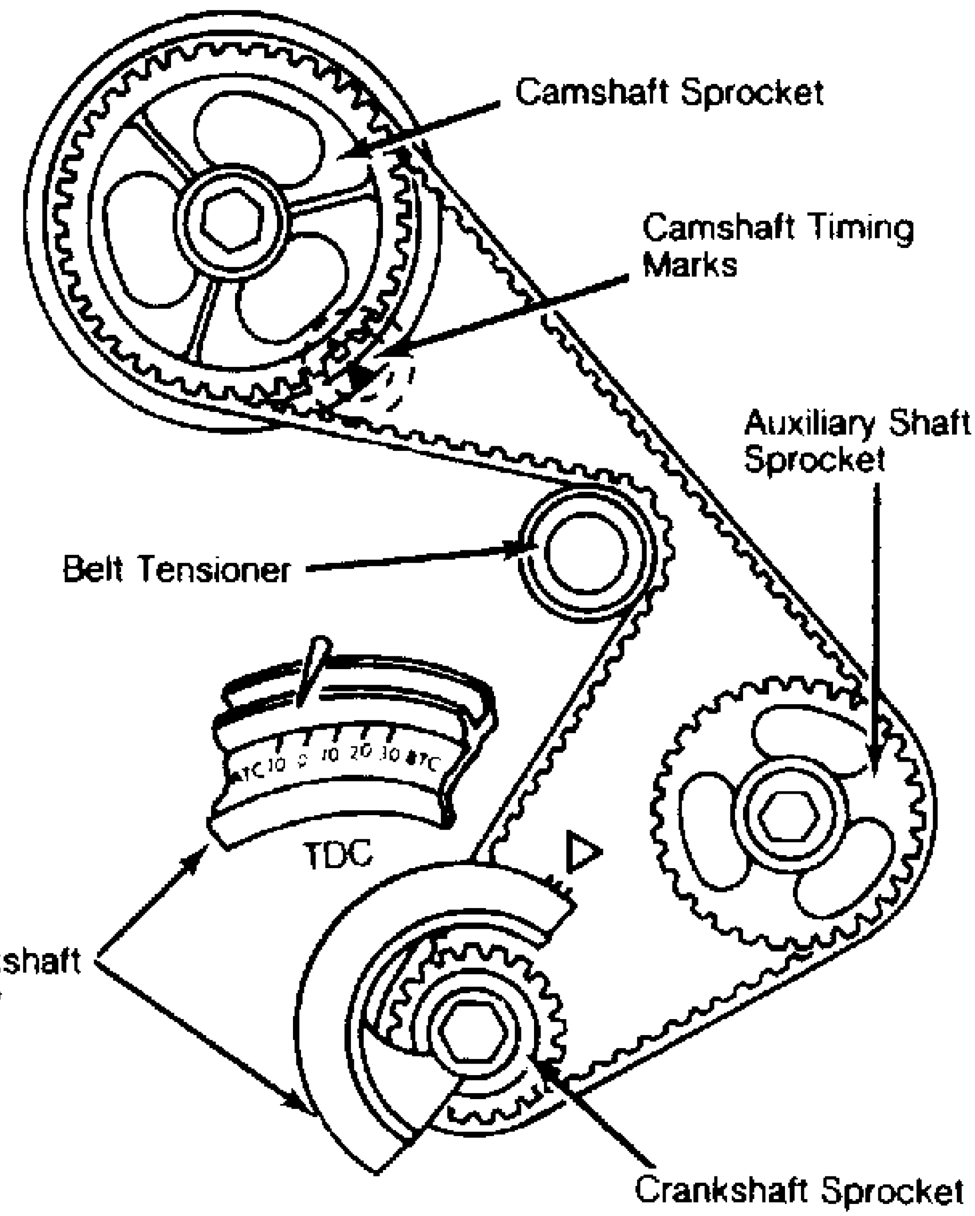

Fig. 25: Timing Belt Sprocket Alignment - Typical
This Graphic For General Information Only

TENSION ADJUSTMENTS

If guide rails are used with spring loaded tensioners, ensure at least half of original rail thickness remains. Spring loaded tensioner should be inspected for damage.

Ensure all timing marks are aligned. Adjust belt tension using manufacturer's recommendations. Belt tension may require checking using tension gauge. See Fig. 26.

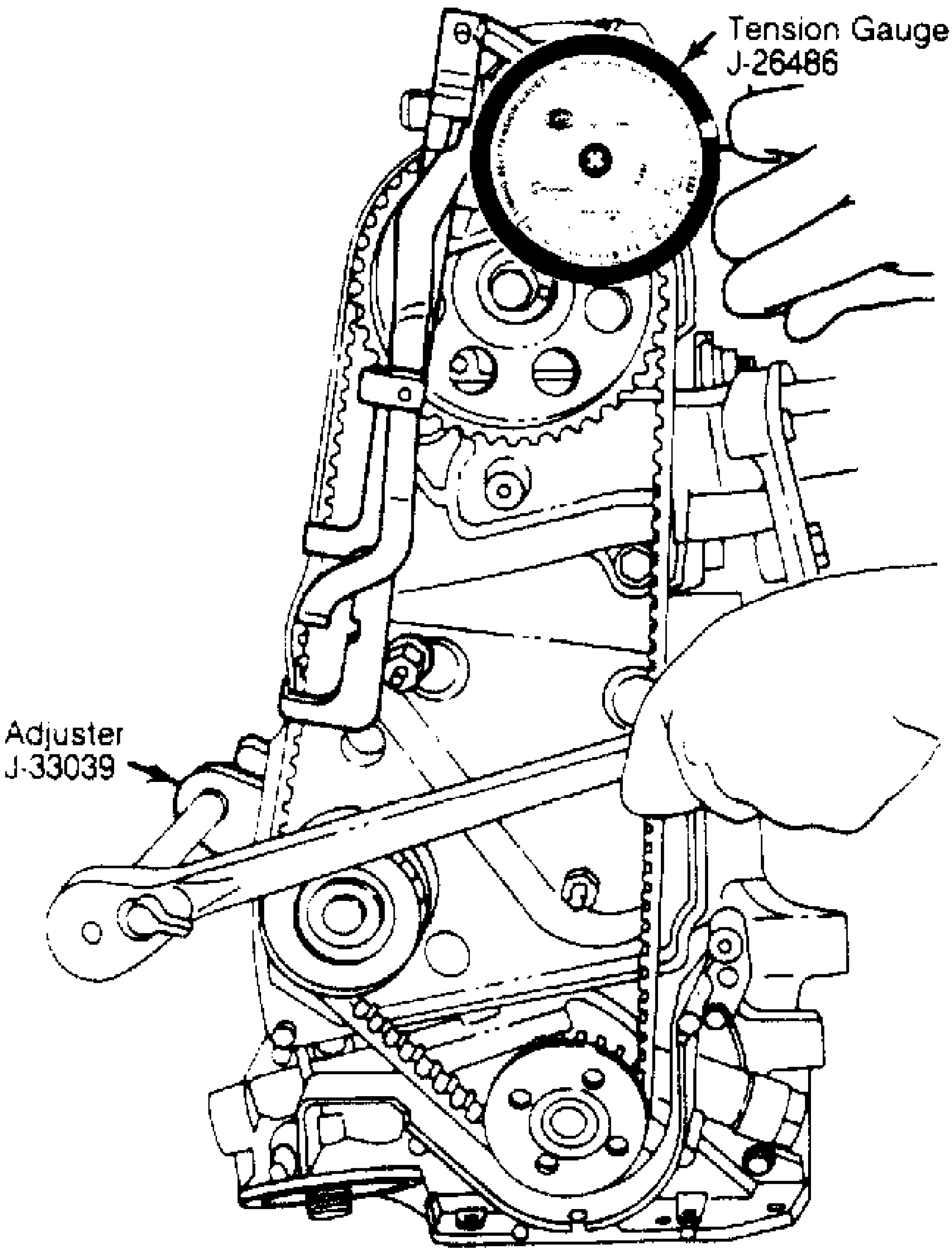

Fig. 26: Timing Belt Tension Adjustment - Typical
This Graphic For General Information Only

TIMING GEARS

* PLEASE READ THIS FIRST *

NOTE: Always refer to appropriate engine overhaul article in the ENGINES section for complete overhaul procedures and specifications for the vehicle being repaired.

TIMING GEAR BACKLASH & RUNOUT

On engines where camshaft gear operates directly on crankshaft gear, gear backlash and runout must be checked. To check backlash, install dial indicator with tip resting on tooth of camshaft gear. Rotate camshaft gear as far as possible. Adjust indicator to zero. Rotate camshaft gear in opposite direction as far as possible and note reading.

To determine timing gear runout, mount dial indicator with tip resting on face edge of camshaft gear. Adjust indicator to zero. Rotate camshaft gear 360 degrees and note reading. If backlash or runout exceed specifications, replace camshaft and/or crankshaft gear.

REAR MAIN OIL SEAL

* PLEASE READ THIS FIRST *

NOTE: Always refer to appropriate engine overhaul article in the ENGINES section for complete overhaul procedures and specifications for the vehicle being repaired.

INSTALLATION

One-Piece Type Seal

For one-piece type oil seal installation, coat block contact surface of seal with sealer if seal is not factory coated. Ensure seal surface is free of burrs. Lubricate seal lip with engine oil and press seal into place using proper oil seal installer. See Fig. 27.

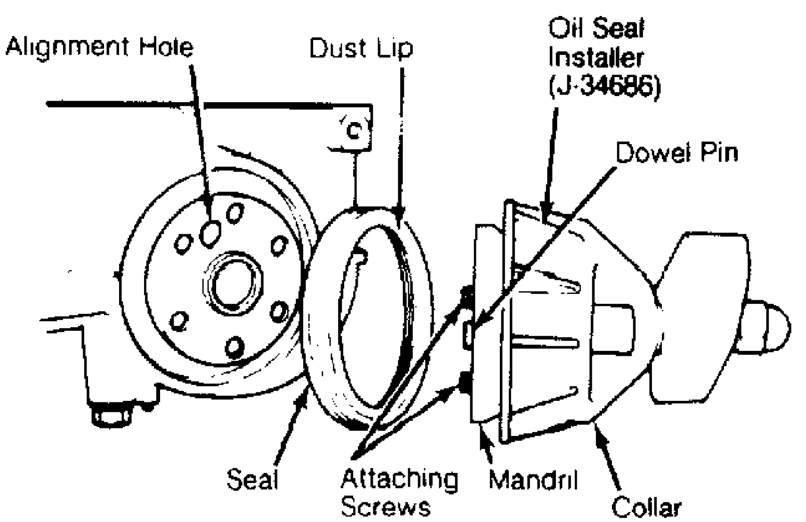

Fig. 27: Installing Typical One-Piece Oil Seal
This Graphic For General Information Only

Rope Type Seal

For rope type rear main oil seal installation, press seal

lightly into its seat. Using seal installer, fully seat seal in bearing cap or cylinder block.

Trim seal ends even with block parting surface. Some applications require sealer to be applied on main bearing cap prior to installation. See Fig. 28.

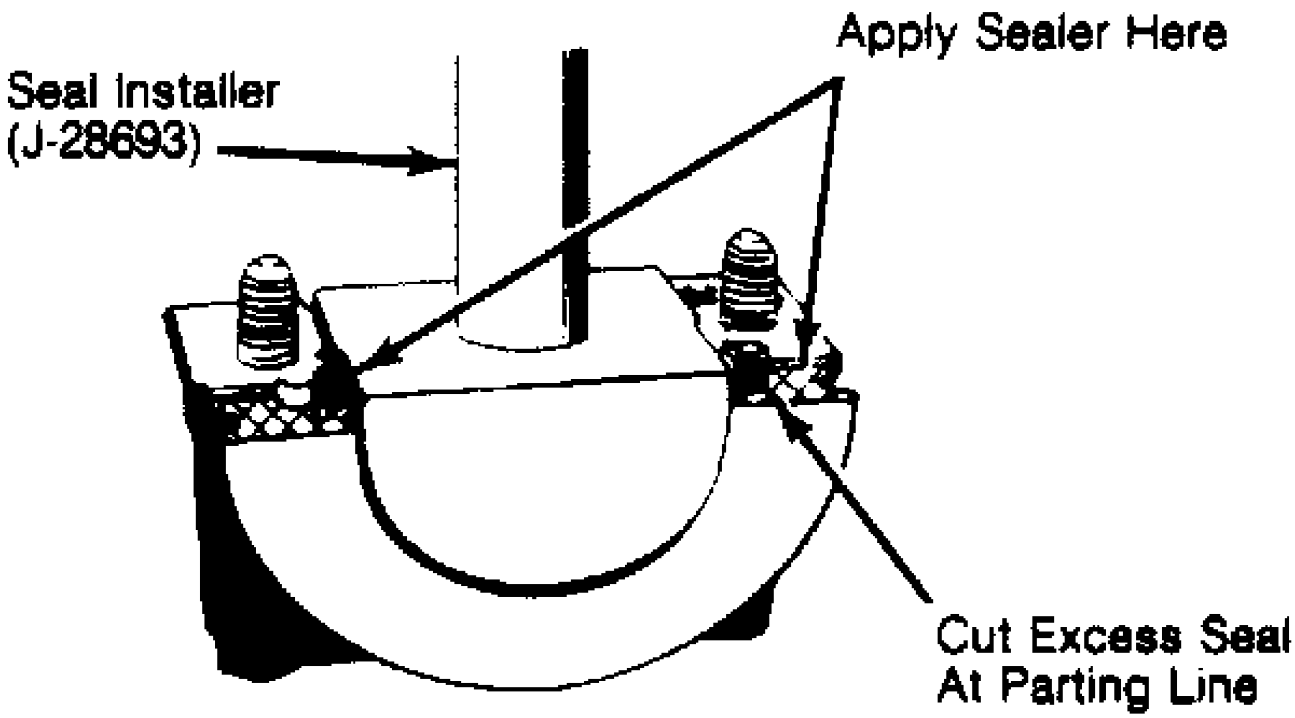

Fig. 28: Typical Rope Seal Installation
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Split-Rubber Type Seal

Follow manufacturers procedures when installing split-rubber type rear main oil seals. Installation procedures vary with engine type. See appropriate ENGINE article in this section. See Fig. 29.

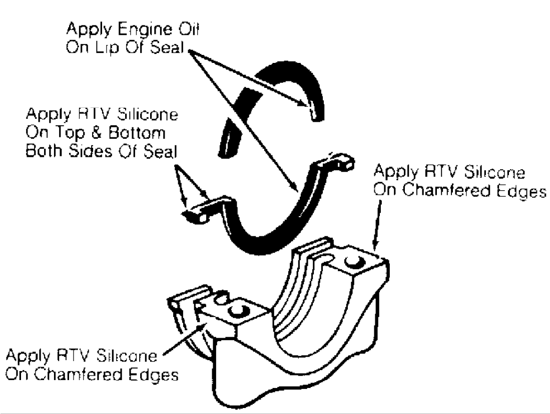

Fig. 29: Typical Split-Rubber Seal Installation
This Graphic For General Information Only

OIL PUMP

* PLEASE READ THIS FIRST *

NOTE: Always refer to appropriate engine overhaul article in the ENGINES section for complete overhaul procedures and specifications for the vehicle being repaired.

ROTOR-TYPE

Oil pump rotors must be marked for location prior to removal. See Fig. 30. Remove outer rotor and measure thickness and diameter. Measure inner rotor thickness. Inspect shaft for scoring or wear. Inspect rotors for pitting or damage. Inspect cover for grooving or wear. Replace components if worn or damaged.

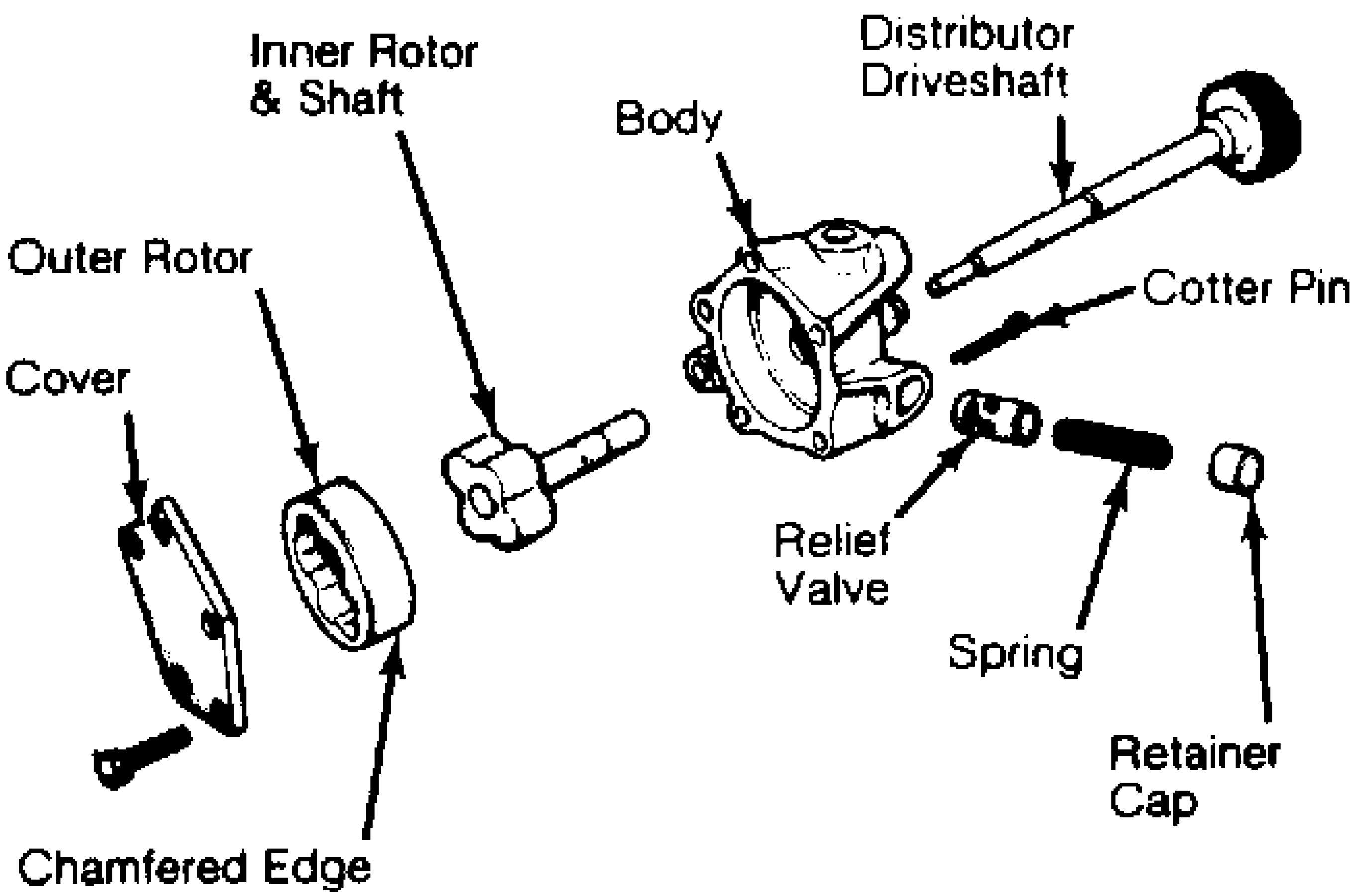

Fig. 30: Typical Rotor Type Oil Pump
This Graphic For General Information Only

Measure outer rotor-to-body clearance. Replace pump assembly if clearance exceeds specification. Measure clearance between rotors. See Fig. 31. Replace shaft and both rotors if clearance exceeds specifications.

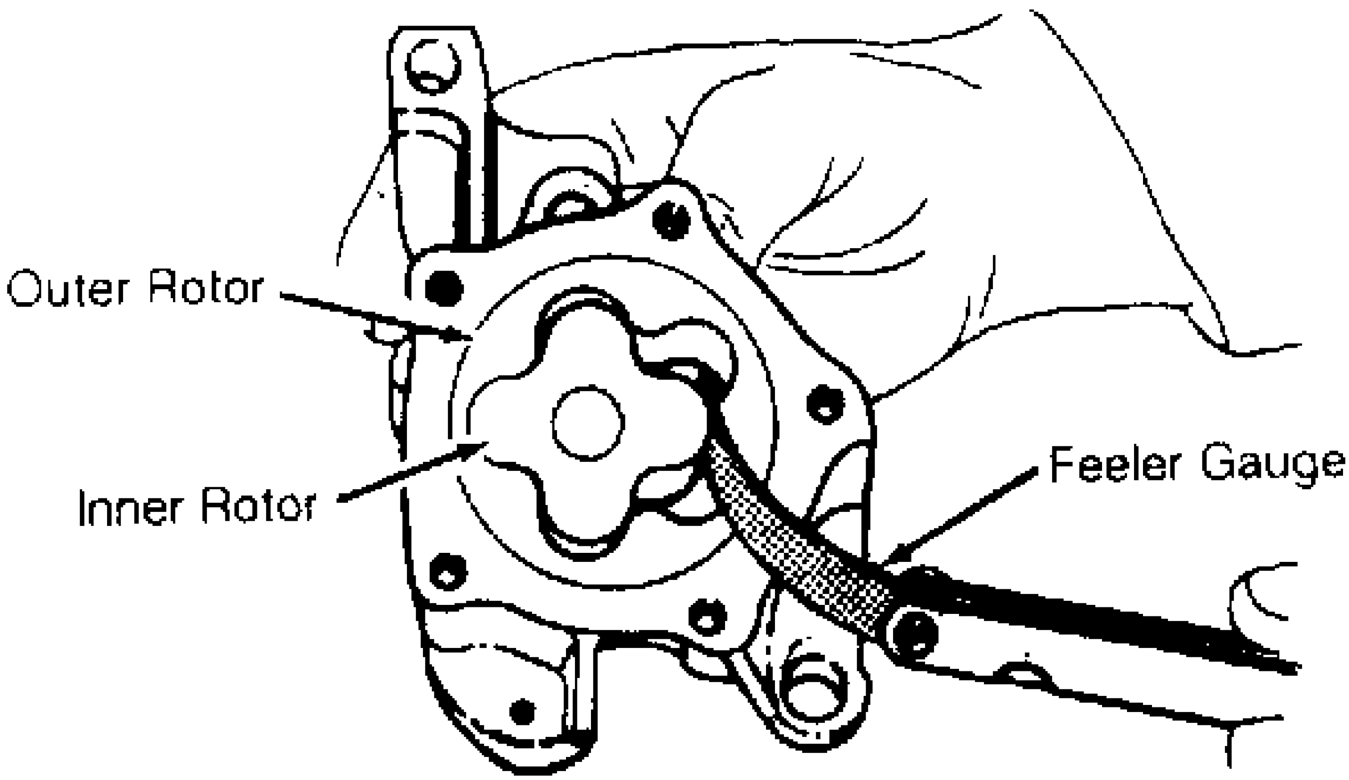

Fig. 31: Measuring Rotor Clearance - Typical
This Graphic For General Information Only

Install rotors in pump body. Position straightedge across pump body. Using feeler gauge, measure clearance between rotors and straightedge. Pump cover wear is measured using a straightedge and feeler gauge. Replace pump if clearance exceeds specification.

GEAR TYPE

Oil pump gears must be marked for location prior to removal. See Fig. 32. Remove gears from pump body. Inspect gears for pitting or damage. Inspect cover for grooving or wear.

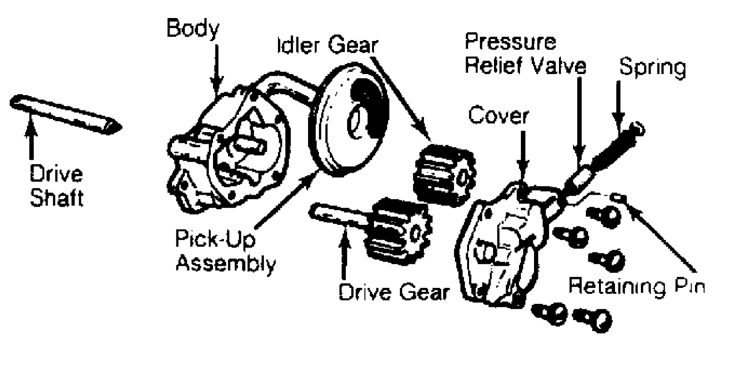

Fig. 32: Typical Gear Type Oil Pump
This Graphic For General Information Only

Measure gear diameter and length. Measure gear housing cavity depth and diameter. See Fig. 33. Replace components if worn or

damaged.
Pump cover wear is measured using a straightedge and feeler gauge. Pump is to be replaced if warpage or wear exceeds specifications or mating surface of pump cover is scratched or grooved.

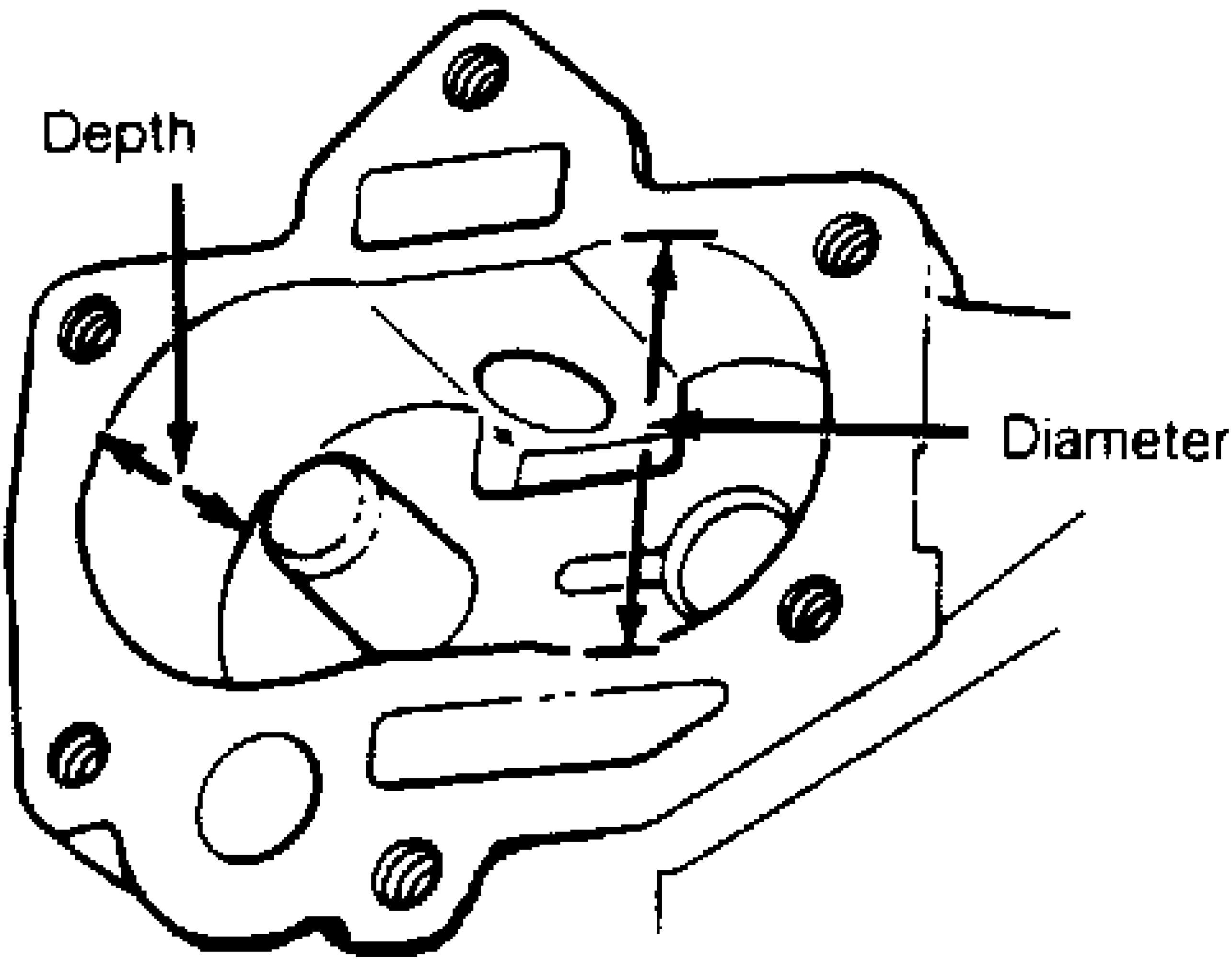

Fig. 33: Measuring Oil Pump Gear Cavity - Typical
This Graphic For General Information Only

BREAK-IN-PROCEDURE

* PLEASE READ THIS FIRST *

NOTE: Always refer to appropriate engine overhaul article in the ENGINES section for complete overhaul procedures and specifications for the vehicle being repaired.

ENGINE PRE-OILING

Engine pre-oiling should be done prior to operation to prevent engine damage. A lightly oiled pump will cavitate unless oil pump cavities are filled with engine oil or petroleum jelly.

Engine pre-oiling can be done using pressure oiler (if available). Connect pressure oiler to cylinder block oil passage such as oil pressure sending unit. Operate pressure oiler long enough to ensure correct amount of oil has filled crankcase. Check oil level while pre-oiling.

If pressure oiler is not available, disconnect ignition system. Remove oil pressure sending unit and replace with oil pressure test gauge. Using starter motor, rotate engine starter until gauge shows normal oil pressure for several seconds. DO NOT crank engine for more than 30 seconds to avoid starter motor damage.

Ensure oil pressure has reached the most distant point from the oil pump. Reinstall oil pressure sending unit. Reconnect ignition system.

INITIAL START-UP

Start the engine and operate engine at low speed while checking for coolant, fuel and oil leaks. Stop engine. Recheck coolant and oil level. Adjust if necessary.

CAMSHAFT

Break-in procedure is required when a new or reground camshaft has been installed. Operate and maintain engine speed between 1500-2500 RPM for approximately 30 minutes. Procedure may vary due to manufacturers recommendations.

PISTON RINGS

Piston rings require a break-in procedure to ensure seating of rings to cylinder walls. Serious damage may occur to rings if correct procedures are not followed.

Extremely high piston ring temperatures are produced obtained during break-in process. If rings are exposed to excessively high RPM or high cylinder pressures, ring damage can occur. Follow piston ring manufacturer's recommended break-in procedure.

FINAL ADJUSTMENTS

Check or adjust ignition timing and dwell (if applicable). Adjust valves (if necessary). Adjust carburetion or injection idle speed and mixture. Retighten cylinder heads (if required). If cylinder head or block is aluminum, retighten bolts when engine is cold. Follow the engine manufacturer's recommended break-in procedure and maintenance schedule for new engines.

NOTE: Some manufacturer's require that head bolts be retightened after specified amount of operation. This must be done to prevent head gasket failure.

ENGINE REMOVAL - 4-CYL

1988 Jeep Cherokee

1988 ENGINES
Jeep - Engine Removal - 4-Cylinder

Cherokee, Comanche, Wrangler

4-CYLINDER ENGINES

2.5L

1) Disconnect negative battery cable. Drain cooling system. Remove air cleaner, lower radiator hose, fan shroud, and engine compartment light from hood. Scribe hinge locations and remove hood. Disconnect automatic transmission cooler lines at radiator (if equipped).

2) Remove upper radiator hose, fan assembly and coolant recovery hose. Remove radiator and A/C condenser (if equipped). Hold fan pulley to water pump flange using 5/16" x 1/2" SAE capscrew. Disconnect heater hoses, throttle linkages, cruise control cable (if equipped) and Throttle valve rod.

3) Disconnect wires from starter and separate CEC system wiring harness connector. Disconnect fuel pipe from fuel pump and fuel return hose from fuel filter. Disconnect hoses from A/C compressor and power steering pump (if equipped). Drain power steering pump reservoir. Cap all fittings and hose ends.

4) Remove vacuum check valve from brake booster (if equipped). Tag and remove all wiring and vacuum lines connected to engine or accessories. Raise vehicle and remove starter. Disconnect exhaust pipe from manifold.

5) Remove converter/flywheel housing cover. Remove engine mount nuts at bracket side. On automatic transmission models, index mark drive plate and torque converter. Remove drive plate-to-converter bolts.

6) Remove upper and loosen lower bellhousing-to-engine bolts. Attach lifting equipment to engine. Raise engine off front mounts, Place support under bellhousing. Remove remaining bellhousing-to-engine bolts. Lift engine out of engine compartment.

NOTE: Engine mount pads may be removed from engine brackets to align engine and transmission during installation.

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS TABLE

Application	Ft. Lbs. (N.m)
Clutch Housing-to-Block Bolts	55 (75)
Drive Plate-to-Converter	26 (35)
Flywheel Bolts	(1) 50 (68)
Front Support Bracket-to-Block	45 (61)
Front Support Cushion-to-Crossmember	33 (45)
Rear Support Bracket-to-Transmission	33 (45)
Rear Support Cushion-to-Bracket	30 (41)
Starter Motor-to-Block	33 (45)

(1) - Tighten an additional 60 degrees.

ENGINE REMOVAL - 6-CYL

1988 Jeep Cherokee

1988 ENGINES
Jeep - Engine Removal - 6-Cylinder

Cherokee, Comanche, Wagoneer, Wrangler

6-CYLINDER ENGINES

4.0L

1) Scribe hinge locations, remove engine compartment light (if equipped) and remove hood. Disconnect battery cables and remove battery. Drain cooling system.

2) Disconnect wire connectors from alternator, ignition coil and distributor. Disconnect oil pressure sender wire, starter wires and fuel injector wiring harness (if equipped). Detach 2 fuel pipe quick connect couplings at left inner fender panel. Disconnect engine ground strap and remove air cleaner.

3) Disconnect the vacuum purge hose at fuel vapor canister tee. Disconnect wire from idle speed actuator and oxygen sensor. Detach throttle cable from bracket and disconnect throttle valve rod at bellcrank. Remove upper and lower radiator hoses.

4) On automatic transmission models, disconnect the transmission fluid cooler tubing. On all models, remove fan shroud and radiator. Remove fan and spacer or Tempatrol fan assembly. Hold fan pulley to water pump flange using 5/16" x 1/2" SAE capscrew while crankshaft is rotated.

5) Disconnect cruise control cable (if equipped). Disconnect wires from starter motor solenoid and disconnect CEC system harness. Remove power brake vacuum check valve from booster (if equipped).

6) Disconnect power steering hoses from steering gear (if equipped). Drain power steering pump reservoir and plug end of hoses. Cap all fittings on steering gear and hoses. Raise and support vehicle. Remove starter. Remove flywheel housing access cover.

7) Remove upper and loosen lower bellhousing-to-engine bolts. Attach lifting equipment to engine. Raise engine off front mounts. Place support under bellhousing. Remove remaining bellhousing-to-engine bolts. Lift engine out of engine compartment.

4.2L

1) Remove battery and drain cooling system. Remove air cleaner and engine compartment light from hood. Scribe hinge location and remove hood. Disconnect and plug front fuel line at pump and fuel return line at frame.

2) Disconnect heater hoses at heater. Label and disconnect all wiring, lines, linkage and hoses at engine. Remove vacuum switch assembly bracket from cylinder head cover. Remove both radiator hoses and automatic transmission oil lines (if equipped) at radiator. Remove radiator and shroud.

3) Remove fan and spacer. Use 5/16" x 1/2" SAE bolt to hold fan pulley to water pump flange. Remove starter and disconnect engine ground strap. Remove engine mount-to-bracket nuts. Disconnect exhaust pipe at manifold.

4) Discharge A/C system (if equipped). Disconnect and plug hose or port openings at compressor. Disconnect hoses at power steering gear and drain reservoir. Remove power brake vacuum check valve. Remove bracket bolt for automatic transmission filler tube (if equipped).

5) Lift and support vehicle. On models with automatic

transmission, remove converter housing cover. Index mark converter and driven plate for reassembly. Remove driven plate-to-converter bolts, rotating crankshaft to access each bolt. Remove oil pan bolts holding automatic transmission oil lines. On Wrangler models, remove exhaust pipe support brace at converter housing.

6) On manual transmission models, remove flywheel housing cover. Remove inner support bolts for clutch release arm. Disconnect springs and remove clutch release arm. Remove outer bracket retainer for release lever rod. On all models, remove upper and loosen lower bellhousing bolts.

7) Lower vehicle. Support transmission. If A/C equipped, remove idler pulley and mounting bracket. Attach lifting equipment to engine. Raise engine off front mounts and support transmission. Remove lower bellhousing bolts. Lift engine from compartment while pulling forward.

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS TABLE

Application	Ft. Lbs. (N.m)
Automatic Transmission-to-Block	28 (38)
Clutch Housing-to-Block	
Top	27 (37)
Bottom	43 (58)
Drive Plate-to-Converter	22 (30)
Drive Plate/Flywheel-to-Crankshaft	105 (143)
Front Support Bracket-to-Block	35 (47)
Front Support Cushion-to-Bracket	33 (45)
Front Support Cushion-to-Crossmember	37 (50)
Rear Support Bracket-to-Transmission	33 (45)
Rear Support Cushion-to-Bracket	30 (41)
Starter Motor-to-Converter Housing	18 (24)

* ENGINE SYSTEMS UNIFORM INSPECTION GUIDELINES *

1988 Jeep Cherokee

GENERAL INFORMATION
Engine Performance and Maintenance Motorist Assurance Program
Standards For Automotive Repair

All Makes and Models

INTRODUCTION TO MOTORIST ASSURANCE PROGRAM (MAP)

CONTENTS

CLUTCH PEDAL POSITION SWITCHES
COLD START INJECTORS
CONNECTORS
COOLANT
COOLANT RECOVERY TANKS
COOLING FAN MOTOR MODULES
COOLING FAN MOTOR RELAYS AND MODULES
COOLING FAN MOTOR RESISTORS
COOLING FAN MOTOR SENSORS AND SWITCHES
COOLING FAN MOTOR SWITCHES
COOLING FAN MOTORS
CRANKSHAFT POSITION SENSORS
DECEL VALVES
DEFLECTORS
DIP STICKS AND TUBES
DIP STICK TUBES
DISTRIBUTOR ADVANCES AND RETARDERS (MECHANICAL AND VACUUM)
DISTRIBUTOR BOOTS AND SHIELDS
DISTRIBUTOR CAPS
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DISTRIBUTOR ROTORS
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EARLY FUEL EVAPORATION VALVES (HEAT RISER ASSEMBLIES)
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EGR EXHAUST MANIFOLD PASSAGES
EGR INTAKE AND EXHAUST MANIFOLD PASSAGES
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ELECTRONIC SPARK CONTROL MODULES
ELECTRONIC TRANSMISSION CONTROL DEVICES
ELECTRONIC TRANSMISSION FEEDBACK DEVICES
ENGINE COOLANT TEMPERATURE SENSORS
ENGINE COOLING SYSTEMS
ENGINE COVERS (OIL PAN, VALVE COVER, TIMING COVER)
ENGINE OIL
ENGINE OIL CANISTERS
ENGINE OIL COOLERS (EXTERNAL)
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ENGINE OIL FILTERS AND CANISTERS
ENGINE OIL GASKETS
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EVAPORATIVE EMISSION (EVAP) CANISTER FILTERS
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EVAPORATIVE EMISSION (EVAP) CANISTERS
EVAPORATIVE EMISSION (EVAP) FEEDBACK DEVICES
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EXHAUST GAS RECIRCULATION FEEDBACK DEVICES
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FUEL
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FUEL DAMPERS
FUEL DELIVERY CHECK VALVES
FUEL DISTRIBUTORS (BOSCH CIS)
FUEL FILLER NECKS AND RESTRICTORS
FUEL FILTERS
FUEL INJECTORS
FUEL LEVEL SENDERS7
FUEL PRESSURE REGULATORS
FUEL PUMPS (IN-TANK AND EXTERNAL, ELECTRICAL OR MECHANICAL)
FUEL RAILS
FUEL RESTRICTORS

FUEL TANKS
GAS CAPS
GASKETS
GROMMETS (VALVE COVER)
HARMONIC DAMPERS
HEATER CONTROL VALVES
HEATER CORES
HOSE AND TUBE COUPLERS, CONNECTORS AND CLAMPS
HOSE CLAMPS
HOSE CONNECTORS
HOSE COUPLERS
HOSES AND TUBES (FUEL LINES, RADIATOR, VACUUM, BY PASS,
  HEATER, RECOVERY TANK AND OIL COOLERS)
HOUSINGS
IDLE AIR CONTROLS
IDLE SPEED CONTROL ACTUATORS
IGNITION BOOTS
IGNITION COIL TOWERS
IGNITION COILS
IGNITION CONTROL MODULES (ICM)
IGNITION SWITCHES
IGNITION TERMINALS
IGNITION WIRES, BOOTS, COIL TOWERS AND TERMINALS (SECONDARY)
IN-TANK FUEL STRAINERS
INERTIA FUEL SHUT-OFF SWITCHES
INTAKE AIR TEMPERATURE SENSORS
INTAKE MANIFOLDS
INTERCOOLERS
KNOCK SENSORS
LIQUID VAPOR SEPARATORS
MANIFOLD ABSOLUTE PRESSURE (MAP) SENSORS
MASS AIR FLOW (MAF) SENSORS
METAL AIR MANIFOLDS AND PIPES
METAL AIR PIPES
MIX CONTROL SOLENOIDS
MOTOR MOUNTS
O-RINGS, GASKETS, SEALS AND SPRING LOCKS
O2 SENSORS
OIL PRESSURE SENDING UNITS
OIL PUMP PICK-UP SCREENS
OIL PUMPS
PARK NEUTRAL POSITION SWITCHES
PCV BREATHER ELEMENTS
PCV ORIFICES
PCV VALVES
PICK-UP ASSEMBLIES (INCLUDES MAGNETIC, HALL EFFECT AND
  OPTICAL)
POWER STEERING PRESSURE SENSORS
POWERTRAIN CONTROL MODULES (PCM) AND PROM
POWERTRAIN CONTROL PROM
PRESSURIZED EXPANSION TANK CAPS
RADIATOR CAPS AND PRESSURIZED EXPANSION TANK CAPS
RADIATOR FAN BLADES
RADIATOR FAN CLUTCHES
RADIATORS
ROLL OVER VALVES
SEALING COMPOUNDS
SEALS
SECONDARY AIR INJECTION SYSTEM MANAGEMENT DEVICES
SENSORS AND ACTUATORS
SHROUDS, BAFFLES AND DEFLECTORS
SPARK PLUGS
SPRING LOCKS

SUPER CHARGERS
SWITCHES
THERMAL VACUUM VALVES
THERMOSTATIC AIR DOOR ASSEMBLIES
THERMOSTATS AND HOUSINGS
THROTTLE BODIES
THROTTLE CABLES
THROTTLE LINKAGES AND CABLES
THROTTLE POSITION SENSORS
THROTTLE POSITION SWITCHES
TIMING BELT SPROCKETS
TIMING BELTS
TORQUE STRUTS
TRANSMISSION RANGE SWITCHES
TUBE CLAMPS
TUBE CONNECTORS
TUBE COUPLERS
TUBES
TURBO CHARGERS
VACUUM CONNECTIONS
VACUUM HOSES, TUBES AND CONNECTIONS (NON-METALLIC)
VACUUM REGULATOR SOLENOIDS
VACUUM TUBES
VEHICLE SPEED SENSORS
VOLUME AIR FLOW SENSORS
WASTE GATE CONTROL SOLENOIDS
WASTE GATES AND BOOST CONTROL MECHANISMS
WATER PUMPS (ELECTRIC)
WATER PUMPS (NON-ELECTRIC)
WIRING HARNESSES AND CONNECTORS

INTRODUCTION TO MOTORIST ASSURANCE PROGRAM (MAP)

OVERVIEW OF MOTORIST ASSURANCE PROGRAM

The Motorist Assurance Program is the consumer outreach effort of the Automotive Maintenance and Repair Association, Inc. (AMRA). Participation in the Motorist Assurance Program is drawn from retailers, suppliers, independent repair facilities, vehicle manufacturers and industry associations.

Our organization’s mission is to strengthen the relationship between the consumer and the auto repair industry. We produce materials that give motorists the information and encouragement to take greater responsibility for their vehicles-through proper, manufacturer-recommended, maintenance. We encourage participating service and repair shops (including franchisees and dealers) to adopt (1) a Pledge of Assurance to their Customers and (2) the Motorist Assurance Program Standards of Service. All participating service providers have agreed to subscribe to this Pledge and to adhere to the promulgated Standards of Service demonstrating to their customers that they are serious about customer satisfaction.

These Standards of Service require that an inspection of the vehicle’s (problem) system be made and the results communicated to the customer according to industry standards. Given that the industry did not have such standards, the Motorist Assurance Program successfully promulgated industry inspection communication standards in 1994-95 for the following systems: Exhaust, Brakes, ABS, Steering and Suspension, Engine Maintenance and Performance, HVAC, and Electrical Systems. Further, revisions to all of these inspection communication standards are continually re-published. In addition to these, standards for Drive Train and Transmissions have recently been promulgated. Participating shops utilize these Uniform Inspection & Communication

Standards as part of the inspection process and for communicating their findings to their customers.

The Motorist Assurance Program continues to work cooperatively and proactively with government agencies and consumer groups toward solutions that both benefit the customer and are mutually acceptable to both regulators and industry. We maintain the belief that industry must retain control over how we conduct our business, and we must be viewed as part of the solution and not part of the problem. Meetings with state and other government officials (and their representatives), concerned with auto repair and/or consumer protection, are conducted. Feedback from these sessions is brought back to the association, and the program adjusted as needed.

To assure auto repair customers recourse if they were not satisfied with a repair transaction, the Motorist Assurance Program offers mediation and arbitration through MAP/BBB-CARE and other non-profit organizations. MAP conducted pilot programs in twelve states before announcing the program nationally in October, 1998. During the pilots, participating repair shops demonstrated their adherence to the Pledge and Standards and agreed to follow the UICS in communicating the results of their inspection to their customers. To put some "teeth" in the program, an accreditation requirement for shops was initiated. The requirements are stringent, and a self-policing method has been incorporated which includes the "mystery shopping" of outlets.

We welcome you to join us as we continue our outreach... with your support, both the automotive repair industry and your customers will reap the benefits. Please visit MAP at our Internet site www. motorist.org or contact us at:

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Phone (202) 712-9042 Fax (202) 216-9646
January 1999

MAP UNIFORM INSPECTION GENERAL GUIDELINES

OVERVIEW OF SERVICE REQUIREMENTS AND SUGGESTIONS

It is MAP policy that all exhaust, brake, steering, suspension, wheel alignment, drive-line, engine performance and maintenance, and heating, ventilation and air conditioning, and electrical services be offered and performed under the standards and procedures specified in these sections.

Before any service is performed on a vehicle, an inspection of the appropriate system must be performed. The results of this inspection must be explained to the customer and documented on an inspection form. The condition of the vehicle and its components will indicate what services/part replacements may be "Required" or "Suggested". In addition, suggestions may be made to satisfy the requests expressed by the customer.

When a component is suggested or required to be repaired or replaced, the decision to repair or replace must be made in the customer’s best interest, and at his or her choice given the options available.

This section lists the various parts and conditions that indicate a required or suggested service or part replacement. Although this list is extensive, it is not fully inclusive. In addition to this list, a technician may make a suggestion. However, any suggestions must be based on substantial and informed experience, or the vehicle manufacturer’s recommended service interval and must be documented.

Some conditions indicate that service or part replacement is

required because the part in question is no longer providing the function for which it is intended, does not meet a vehicle manufacturer's design specification or is missing.

Example:
An exhaust pipe has corroded severely and has a hole in it through which exhaust gases are leaking. Replacement of the exhaust pipe in this case is required due to functional failure.

Example:
A brake rotor has been worn to the point where it measures less than the vehicle manufacturer's discard specifications. Replacement of the rotor is required because it does not meet design specifications.

Some conditions indicate that a service or part replacement is suggested because the part is close to the end of its useful life or addresses a customer's need, convenience or request. If a customer's vehicle has one of these conditions, the procedure may be only to suggest service.

Example:
An exhaust pipe is rusted, corroded or weak, but no leaks are present. In this case, the exhaust pipe has not failed. However, there is evidence that the pipe may need replacement in the near future. Replacement of the pipe may be suggested for the customer's convenience in avoiding a future problem.

Example:
The customer desires improved ride and/or handling, but the vehicle's shocks or struts have not failed. In this case, replacement may be suggested to satisfy the customer's wishes. In this case, replacement of the shocks or struts may not be sold as a requirement.

A customer, of course, has the choice of whether or not a shop will service his or her vehicle. He or she may decide not to follow some of your suggestions. When a repair is required, a MAP shop must refuse partial service on that system if, in the judgment of the service provider, proceeding with the work could create or continue an unsafe condition. When a procedure states that required or suggested repair or replacement is recommended, the customer must be informed of the generally acceptable repair/replacement options whether or not performed by the shop.

When presenting suggested repairs to the customer, you must present the facts, allowing the customer to draw their own conclusions and make an informed decision about how to proceed.

The following reasons may be used for required and suggested services. These codes are shown in the "Code" column of the MAP Uniform Inspection & Communications Standards that follow:

Reasons to Require Repair or Replacement

A - Part no longer performs intended purpose
B - Part does not meet a design specification (regardless of performance)
C - Part is missing

NOTE: When a repair is required, the shop must refuse partial service to the system in question, if the repair creates or continues an unsafe condition.

Reasons to Suggest Repair or Replacement

1 - Part is close to the end of its useful life (just above discard specifications, or weak; failure likely to occur soon, etc.)
2 - To address a customer need, convenience, or request (to stiffen ride, enhance performance, eliminate noise, etc.)
3 - To comply with maintenance recommended by the vehicle's Original Equipment Manufacturer (OEM)
4 - Technician's recommendation based on substantial and informed experience

NOTE: Suggested services are always optional. When presenting suggested repairs to the customer, you must present the facts, allowing the customer to draw their own conclusions and make an informed decision about how to proceed.

ENGINE ASSEMBLIES

SERVICE PROCEDURES REQUIRED AND SUGGESTED FOR PROPER VEHICLE OPERATION

CYLINDER HEAD ASSEMBLIES

NOTE: A Cylinder Head Assembly is a cylinder head fitted with valves, associated springs, retainers, and on overhead camshaft cylinder heads (OHC), camshaft, camshaft bearings, lash adjusters, tappets and rockers.

CYLINDER HEAD ASSEMBLY INSPECTION

Condition	Code	Procedure
Adjustable valve lash is out of specification	B	Require repair.
Internal component failure (any component)	A	(1) Require repair or replacement of cylinder head assembly.

(1) - It is Required that all other failure related components be inspected for cause and condition. Additional components or assemblies may be Suggested for repair or replacement, such as a water pump on a short block (reason code 4, technician's recommendation based on substantial and informed experience).

Example:
If there is a failed head gasket with an external coolant leak, in addition to Requiring replacement of the head gasket, inspection of the following for cause and condition is Required: Block, Cooling System, Cylinder Head. It may be Suggested that additional inspections be performed, such as the other head gasket on a V-type engine.

LONG BLOCK ASSEMBLIES

NOTE: A Long Block Assembly is a short block assembly together with a cylinder head assembly and all those components fitted within the rocker or cam cover, and timing cover

(the whole presented as an assembly). A rebuilt or new oil pump, or kit shall be supplied or fitted as appropriate.

LONG BLOCK ASSEMBLY INSPECTION

Condition	Code	Procedure
Internal component failure (any component)	A	.... (1) Require repair or replacement of the long block assembly.

(1) - It is Required that all other failure related components be inspected for cause and condition. Additional components or assemblies may be Suggested for repair or replacement such as a water pump on a short block (reason code 4, technician's recommendation based on substantial and informed experience).

Example:
If there is a failed head gasket with an external coolant leak, in addition to Requiring replacement of the head gasket, inspection of the following for cause and condition is Required: Block, Cooling System, Cylinder Head. It may be Suggested that additional inspections be performed, such as the other head gasket on a V-type engine.

SHORT BLOCK ASSEMBLIES

NOTE: A Short Block Assembly is a cylinder block and all those components contained within the limits of the block deck or decks, the pan rail, the block rear face and the timing cover (where fitted), including the crankshaft.

SHORT BLOCK ASSEMBLY INSPECTION

Condition	Code	Procedure
Any internal component failure	A	.... (1) Require repair or replacement of the short block assembly.

(1) - It is Required that all other failure related components be inspected for cause and condition. Additional components or assemblies may be Suggested for repair or replacement, such as a water pump on a short block (reason code 4, technician's recommendation based on substantial and informed experience).

Example:
If there is a failed head gasket with an external coolant leak, in addition to Requiring replacement of the head gasket, inspection of the following for cause and condition is Required: Block, Cooling System, Cylinder Head. It may be Suggested that additional inspections be performed, such as the other head gasket on a V-type engine.

ENGINE COMPONENTS

ACCELERATOR PEDAL POSITION SENSORS

ACCELERATOR PEDAL POSITION SENSOR INSPECTION

Condition	Code	Procedure
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware threads damaged	A	Require repair or replacement of hardware.
Attaching hardware threads stripped (threads missing)	A	Require repair or replacement of hardware.
Connector broken	A	Require repair or replacement.
Connector (Weatherpack type) leaking	A	Require repair or replacement.
Connector melted	A	(1) Require repair or replacement.
Connector missing	C	Require replacement.
Inoperative	B	(2) Require repair or replacement. Further inspection required.
Missing	C	Require replacement.
Resistance out of specification	B	Require repair or replacement.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(1) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.
Threads stripped (threads missing)	A	Require replacement.
Wire lead conductors exposed	B	Require repair or replacement.
Wire lead corroded	A	Require repair or replacement.
Wire lead open	A	Require repair or replacement.
Wire lead shorted	A	Require repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - Inoperative includes intermittent operation or out of OEM specification. Some components may be serviceable; check for accepted cleaning procedure.

ACCESSORY BELTS

ACCESSORY BELT INSPECTION

Condition	Code	Procedure
Alignment incorrect	B	.... (1) Further inspection required.
Cracked	1	.... Suggest replacement.
Frayed	1	.... Suggest replacement.
Missing	C	.... Require replacement.
Noisy	2	.... (2) Further inspection required.
Plies separated	A	.... Require replacement.
Tension out of specification	B	.... Require adjustment or replacement.
Worn beyond adjustment range	B	.... Require replacement.
Worn so it contacts bottom of pulley	A	.... Require replacement.

(1) - Determine cause of incorrect alignment and require repair.
(2) - Determine cause of noise and suggest repair.

ACCESSORY PULLEYS

ACCESSORY PULLEY INSPECTION

Condition	Code	Procedure
Alignment incorrect	B	.. Require repair or replacement.
Attaching hardware broken	A	... Require repair or replacement of hardware.
Attaching hardware missing	C	.... Require replacement of hardware.
Attaching hardware not functioning	A	... Require repair or replacement of hardware.
Bent	A	.... Require replacement.
Cracked	A	.... Require replacement.
Loose	A	.. Require repair or replacement.
Missing	C	.... Require replacement.
Pulley damaged, affecting belt life	A	.... Require replacement.

ACTUATORS

See SENSORS AND ACTUATORS.

AIR CONDITIONING CYCLING SWITCHES

AIR CONDITIONING CYCLING SWITCH INSPECTION

Condition	Code	Procedure
Attaching hardware missing	C	.... Require replacement of hardware.
Attaching hardware threads damaged	A	... Require repair or replacement of hardware.

Condition	Code	Procedure
Attaching hardware threads stripped (threads missing)	A	Require repair or replacement of hardware.
Connector broken	A	Require repair or replacement.
Connector (Weatherpack type) leaking	A	Require repair or replacement.
Connector melted	A	(1) Require repair or replacement.
Connector missing	C	Require replacement.
Contaminated	A	(2) Require repair or replacement.
Inoperative	B	(3) Require repair or replacement. Further inspection required.
Leaking	A	Require repair or replacement.
Missing	C	Require replacement.
Resistance out of specification	B	Require repair or replacement.
Restricted, affecting performance	A	Require repair or replacement.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(1) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.
Wire lead conductors exposed	B	Require repair or replacement.
Wire lead corroded	A	Require repair or replacement.
Wire lead open	A	Require repair or replacement.
Wire lead shorted	A	Require repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - Determine source of contamination, such as engine coolant, fuel, metal particles, or water. Require repair or replacement.
(3) - Inoperative includes intermittent operation or out of OEM specification. Some components may be serviceable; check for accepted cleaning procedure.

AIR CONDITIONING PRESSURE SENSORS

AIR CONDITIONING PRESSURE SENSOR INSPECTION

Condition	Code	Procedure
Attaching hardware missing	C	Require replacement of hardware.

Attaching hardware threads damaged	A	Require repair or replacement of hardware.
Attaching hardware threads stripped (threads missing)	A	Require repair or replacement of hardware.
Connector broken	A	Require repair or replacement.
Connector (Weatherpack type) leaking	A	Require repair or replacement.
Connector melted	A	(1) Require repair or replacement.
Connector missing	C	Require replacement.
Contaminated	A	(2) Require repair or replacement.
Inoperative	B	(3) Require repair or replacement. Further inspection required.
Leaking	A	Require repair or replacement.
Missing	C	Require replacement.
Resistance out of specification	B	Require repair or replacement.
Restricted, affecting performance	A	Require repair or replacement.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(1) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.
Wire lead conductors exposed	B	Require repair or replacement.
Wire lead corroded	A	Require repair or replacement.
Wire lead open	A	Require repair or replacement.
Wire lead shorted	A	Require repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - Determine source of contamination, such as engine coolant, fuel, metal particles, or water. Require repair or replacement.
(3) - Inoperative includes intermittent operation or out of OEM specification. Some components may be serviceable; check for accepted cleaning procedure.

AIR DUCTS AND TUBES

AIR DUCT AND TUBE INSPECTION

Condition	Code	Procedure

Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Leaking	A	Require repair or replacement.
Missing	C	Require replacement.
Restricted, affecting performance	A	Require repair or replacement.

AIR FILTER ELEMENTS

AIR FILTER ELEMENT INSPECTION

Condition	Code	Procedure
Leaking	A	Require replacement.
Paper filter element oil-soaked	A	(1) Require replacement.
Maintenance intervals	3	Suggest replacement to comply with vehicle's OEM recommended service intervals.
Melted	A	Required replacement.
Missing	C	Require replacement.
Restricted, affecting performance	A	Require replacement.
Water-contaminated	A	(1) Require replacement.

(1) - Further inspection required to determine cause.

AIR FILTER GASKETS

See AIR FILTER HOUSINGS AND GASKETS.

AIR FILTER HOUSINGS AND GASKETS

AIR FILTER HOUSING AND GASKET INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Leaking	A	Require repair or replacement.
Missing	C	Require replacement.

AIR FUEL RATIO SENSORS

AIR FUEL RATIO SENSOR INSPECTION

Condition	Code	Procedure
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware threads damaged	A	Require repair or replacement of hardware.
Attaching hardware threads stripped (threads missing)	A	Require repair or replacement of hardware.
Connector broken	A	Require repair or replacement.
Connector (Weatherpack type) leaking	A	Require repair or replacement.
Connector melted	A	(1) Require repair or replacement.
Connector missing	C	Require replacement.
Contaminated	A	(2) Require repair or replacement.
Inoperative	B	(3) Require repair or replacement. Further inspection required.
Leaking	A	Require repair or replacement.
Missing	C	Require replacement.
Resistance out of specification	B	Require repair or replacement.
Restricted, affecting performance	A	Require repair or replacement.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(1) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.
Wire lead conductors exposed	B	Require repair or replacement.
Wire lead corroded	A	Require repair or replacement.
Wire lead open	A	Require repair or replacement.
Wire lead shorted	A	Require repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - Determine source of contamination, such as engine coolant, fuel, metal particles, or water. Require repair or replacement.
(3) - Inoperative includes intermittent operation or out of OEM specification. Some components may be serviceable; check for accepted cleaning procedure.

AIR INJECTION CONTROL SOLENOIDS

AIR INJECTION CONTROL SOLENOID INSPECTION

Condition	Code	Procedure
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware threads damaged	A	Require repair or replacement of hardware.
Attaching hardware threads stripped (threads missing)	A	Require repair or replacement of hardware.
Connector broken	A	Require repair or replacement.
Connector (Weatherpack type) leaking	A	Require repair or replacement.
Connector melted	A	(1) Require repair or replacement.
Connector missing	C	Require replacement.
Inoperative	B	(2) Require repair or replacement. Further inspection required.
Leaking	A	Require repair or replacement.
Missing	C	Require replacement.
Resistance out of specification	B	Require repair or replacement.
Restricted, affecting performance	A	Require repair or replacement.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(1) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.
Wire lead conductors exposed	B	Require repair or replacement.
Wire lead corroded	A	Require repair or replacement.
Wire lead open	A	Require repair or replacement.
Wire lead shorted	A	Require repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - Inoperative includes intermittent operation or out of OEM specification. Some components may be serviceable; check for accepted cleaning procedure.

AIR PLENUMS

AIR PLENUM INSPECTION

Condition	Code	Procedure
Integrated air or fuel control components inoperative	A	(1) Require repair or replacement.
Internal air or fuel components damaged, affecting performance	A	Require repair or replacement of component.
Internal air or fuel components damaged, not affecting performance	..	No service suggested or required.
Internal air or fuel components missing	C	Require replacement of component.
Leaking	A	Require repair or replacement.
Restricted	A	Require repair or replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require repair or replacement.

(1) - Inoperative includes intermittent operation or out of OEM specification.

AIR PUMP BELTS

AIR PUMP BELT INSPECTION

Condition	Code	Procedure
Alignment incorrect	B	(1) Further inspection required.
Cracked	1	Suggest replacement.
Frayed	1	Suggest replacement.
Maintenance intervals	3	Suggest replacement to comply with vehicle OEM recommended service intervals.
Missing	C	Require replacement.
Noisy	2	(2) Further inspection required.
Plies separated	A	Require replacement.
Tension out of specification	B	Require adjustment or replacement.
Worn beyond adjustment range	B	Require replacement.
Worn so it contacts bottom of pulley	A	Require replacement.

(1) - Determine cause of incorrect alignment and require repair.
(2) - Determine cause of noise and suggest repair.

AIR PUMPS (ELECTRIC-DRIVEN)

AIR PUMP (ELECTRIC-DRIVEN) INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Connector broken	A	Require repair or replacement.
Connector (Weatherpack type) leaking	A	Require repair or replacement.
Connector melted	A	(1) Require repair or replacement.
Connector missing	C	Require replacement.
Inoperative	A	(2) Require replacement.
Leaking	A	Require replacement.
Missing	C	Require replacement.
Noisy	2	Suggest replacement.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(1) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - Inoperative includes intermittent operation or out of OEM specification.

AIR TUBES

See AIR DUCTS AND TUBES.

ASPIRATOR, CHECK AND DECEL VALVES

ASPIRATOR, CHECK AND DECEL VALVE INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement

		of hardware.
Inoperative	A	(1) Require repair or replacement.
Leaking	A	Require replacement.
Melted, affecting performance	A	Require replacement.
Melted, not affecting performance	..	No service suggested or required.
Missing	C	Require replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require repair or replacement.

(1) - Inoperative includes intermittent operation or out of OEM specification.

BAFFLES

See SHROUDS, BAFFLES AND DEFLECTORS.

BALLAST PRIMARY SUPPLY RESISTOR WIRES

See BALLAST RESISTORS AND PRIMARY SUPPLY RESISTOR WIRES.

BALLAST RESISTORS AND PRIMARY SUPPLY RESISTOR WIRES

BALLAST RESISTOR AND PRIMARY SUPPLY RESISTOR WIRE INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Conductor exposed	A	Require replacement.
Connector broken	A	Require repair or replacement.
Connector melted	A	(1) Require repair or replacement.
Connector missing	C	Require replacement.
Inoperative	A	(2) Require replacement.
Insulation overheated	A	Require replacement.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(1) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - Inoperative includes intermittent operation or out of OEM specification.

BAROMETRIC PRESSURE SENSORS

BAROMETRIC PRESSURE SENSOR INSPECTION

Condition	Code	Procedure
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware threads damaged	A	Require repair or replacement of hardware.
Attaching hardware threads stripped (threads missing)	A	Require repair or replacement of hardware.
Connector broken	A	Require repair or replacement.
Connector (Weatherpack type) leaking	A	Require repair or replacement.
Connector melted	A	(1) Require repair or replacement.
Connector missing	C	Require replacement.
Contaminated	A	(2) Require repair or replacement.
Inoperative	B	(3) Require repair or replacement. Further inspection required.
Leaking	A	Require repair or replacement.
Missing	C	Require replacement.
Resistance out of specification	B	Require repair or replacement.
Restricted, affecting performance	A	Require repair or replacement.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(1) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.
Wire lead conductors exposed	B	Require repair or replacement.
Wire lead corroded	A	Require repair or replacement.
Wire lead open	A	Require repair or replacement.
Wire lead shorted	A	Require repair or replacement.

(1) - Determine cause and correct prior to repair or

replacement of part.
(2) - Determine source of contamination, such as engine coolant, fuel, metal particles, or water. Require repair or replacement.
(3) - Inoperative includes intermittent operation or out of OEM specification. Some components may be serviceable; check for accepted cleaning procedure.

BATTERIES

Proper operation of any electrical system or component can be affected by battery condition. The battery(ies) must meet or exceed minimum specification for vehicle as equipped and test to that specific battery's CCA.

Definition of Terms

* Battery Performance Testing
  Testing that determines whether or not a battery meets both vehicle OEM and battery manufacturer's specifications.

* Cold Cranking Amp (CCA) Rating
  The number of amperes a new, fully charged battery at 0° F (-17.8° C) can deliver for 30 seconds and maintain at least a voltage of 1.2 volts per cell (7.2 volts for a 12-volt battery).

* Cranking Amps (CA)
  The number of amperes a new, fully charged battery, typically at 32° F (0° C) can deliver for 30 seconds and maintain at least a voltage of 1.2 volts per cell (7.2 volts for a 12-volt battery).

* OEM Cranking Amps
  The minimum CCA required by the original vehicle manufacturer for a specific vehicle.

BATTERY INSPECTION

Condition	Code	Procedure
Battery frozen	..	(1) Further inspection required.
Case leaking	A	Require replacement.
Casing swollen	A	(2) Further inspection required.
Circuit open internally	A	Require replacement.
Electrolyte contamination	A	(2) Further inspection required.
Electrolyte discoloration	A	(2) Further inspection required.
Fails to accept and hold charge	A	(3) Require replacement.
Fluid level low	B	(4) Further inspection required.
Out of performance specification for battery	B	(5) Require replacement.
Out of specification for application	B	(5) Require replacement.

Post (top or side) burned, affecting performance	A	(6) Require repair or replacement.
Post (top or side) burned, not affecting performance	2	(6) Suggest repair or replacement.
Post (top or side) corroded, affecting performance	A	Require repair.
Post (top or side) corroded, not affecting performance	2	Suggest repair.
Post (top or side) loose	A	Require replacement.
Post (top or side) melted, affecting performance	A	(6) Require repair or replacement.
Post (top or side) melted, not affecting performance	2	(6) Suggest repair or replacement.
Specific gravity low	B	(7) Further inspection required.
State of charge low	A	(7) Further inspection required.
Top dirty	2	Suggest cleaning battery.
Top wet	A	(8) Require cleaning battery. Further inspection required.
Vent cap loose	A	Require repair or replacement of vent cap.
Vent cap missing	C	Require replacement of vent cap.

(1) - DO NOT attempt to charge a frozen battery. Allow battery to warm thoroughly and then performance-test. If battery fails performance test, require replacement.
(2) - No service suggested or required unless the battery fails performance test, in which case, require replacement.
(3) - This phrase refers to a battery that fails to either accept and/or retain a charge using appropriate times listed in the Battery Charging Guide of the BCI Service Manual, battery charger operating manual, or battery manufacturer's specifications.
(4) - Determine cause of low fluid level. Refill to proper level(s) with water (distilled water preferred). Recharge battery and performance-test.
(5) - The battery may meet battery manufacturer's specifications but test below the minimum specification defined by the vehicle's OEM for that vehicle.
(6) - Determine cause and correct prior to repair or replacement of part.
(7) - Recharge and test to manufacturer's specifications. If battery fails performance test, require replacement.
(8) - Check fluid level and adjust to manufacturer's specification. Suggest checking charging system for proper operation.

BATTERY CABLES, WIRES AND CONNECTORS

BATTERY CABLE, WIRE AND CONNECTOR INSPECTION

Condition	Code	Procedure
Application incorrect ...	B	.. Require repair or replacement.
Attaching hardware broken	A	... Require repair or replacement of hardware.
Attaching hardware missing	C	.... Require replacement of hardware.
Attaching hardware not functioning	A	... Require repair or replacement of hardware.
Connector broken	A	.. Require repair or replacement.
Connector melted	A	.... (1) Require repair or replacement.
Connector missing	C	.... Require replacement.
Insulation damaged, conductors exposed	A	.... (2) Require repair or replacement.
Insulation damaged, conductors not exposed .	1	.... Suggest replacement.
Open	A	.. Require repair or replacement.
Protective shield (conduit) melted	2	.... (1) Suggest repair or replacement.
Protective shield (conduit) missing	2	.. Suggest repair or replacement.
Resistance (voltage drop) out of specification ...	A	.. Require repair or replacement.
Routed incorrectly	B	.... Require repair.
Secured incorrectly	B	.... Require repair.
Shorted	A	.. Require repair or replacement.
Terminal broken	A	.. Require repair or replacement.
Terminal burned, affecting performance	A	.... (1) Require repair or replacement.
Terminal burned, not affecting performance ..	2	.. Suggest repair or replacement.
Terminal corroded, affecting performance ..	A	.. Require repair or replacement.
Terminal corroded, not affecting performance ..	2	.. Suggest repair or replacement.
Terminal loose, affecting performance	B	.. Require repair or replacement.
Terminal loose, not affecting performance ..	1	.. Suggest repair or replacement.
Voltage drop out of specification	A	.. Require repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - Exposed conductor at replacement (aftermarket) terminal end does not require repair or replacement.

BATTERY CONNECTORS

See BATTERY CABLES, WIRES AND CONNECTORS.

BATTERY TRAYS AND HOLD DOWN HARDWARE

BATTERY TRAY AND HOLD DOWN HARDWARE INSPECTION

Condition	Code	Procedure
Battery improperly secured	2	Suggest repair.
Bent, affecting performance	A	Require repair or replacement.
Bent, not affecting performance	..	No service suggested or required.
Broken, affecting performance	A	Require repair or replacement.
Broken, not affecting performance	..	No service suggested or required.
Corroded, affecting performance	A	Require repair or replacement.
Corroded, not affecting performance	2	Suggest repair or replacement.
Cracked, affecting performance	A	Require repair or replacement.
Cracked, not affecting performance	1	Suggest repair or replacement.
Missing	C	Require replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.
Water drain clogged	A	Require repair.

BATTERY WIRES

See BATTERY CABLES, WIRES AND CONNECTORS.

BELT-DRIVEN AIR PUMPS

BELT-DRIVEN AIR PUMP INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Inoperative	A	(1) Require replacement.
Leaking	A	Require replacement.
Missing	C	Require replacement.
Noisy	2	Suggest replacement.
Pulley alignment incorrect	B	Require repair or replacement.
Pulley bent	A	Require replacement.
Pulley cracked	A	Require replacement.
Pulley loose	A	Require repair or replacement.
Pulley missing	C	Require replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads		

missing)	A	Require repair or replacement.

(1) - Inoperative includes intermittent operation or out of OEM specification.

BELT IDLER ASSEMBLIES (ACCESSORY AND CAM BELTS)

BELT IDLER ASSEMBLY (ACCESSORY AND CAM BELT) INSPECTION

Condition	Code	Procedure
Alignment incorrect	B	Require repair or replacement.
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Bearings worn	1	Suggest replacement.
Cracked	2	Suggest replacement.
Missing	C	Require replacement.
Noisy	2	Suggest replacement.
Seized	A	Require repair or replacement.

BELT TENSIONERS (ACCESSORY AND CAM BELTS)

BELT TENSIONER (ACCESSORY AND CAM BELT) INSPECTION

Condition	Code	Procedure
Alignment incorrect	B	Require repair or replacement.
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Bearings worn	1	Suggest replacement.
Belt tension incorrect	B	Require adjustment or repair.
Cracked	2	Suggest replacement.
Missing	C	Require replacement.
Noisy	2	Suggest replacement.
Pulley damaged, affecting belt life	A	Require replacement.
Seized	A	Require repair or replacement.

BOOST CONTROL MECHANISMS

See WASTE GATES AND BOOST CONTROL MECHANISMS.

CAMSHAFT POSITION SENSORS

CAMSHAFT POSITION SENSOR INSPECTION

Condition	Code	Procedure
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware threads damaged	A	Require repair or replacement of hardware.
Attaching hardware threads stripped (threads missing)	A	Require repair or replacement of hardware.
Connector broken	A	Require repair or replacement.
Connector (Weatherpack type) leaking	A	Require repair or replacement.
Connector melted	A	(1) Require repair or replacement.
Connector missing	C	Require replacement.
Contaminated	A	(2) Require repair or replacement.
Inoperative	B	(3) Require repair or replacement. Further inspection required.
Leaking	A	Require repair or replacement.
Missing	C	Require replacement.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(1) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.
Wire lead conductors exposed	B	Require repair or replacement.
Wire lead corroded	A	Require repair or replacement.
Wire lead open	A	Require repair or replacement.
Wire lead shorted	A	Require repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - Determine source of contamination, such as engine coolant, fuel, metal particles, or water. Require repair or replacement.
(3) - Inoperative includes intermittent operation or out of OEM specification. Some components may be serviceable; check for accepted cleaning procedure.

CARBURETORS AND CHOKES

NOTE: Proper operation of a carburetor includes the ability to control air/fuel mixtures during all phases or driving operation to comply with all federal and local emissions standards. Adjustments are to be considered repairs.

CARBURETOR AND CHOKE INSPECTION

Condition	Code	Procedure
Air/fuel control incorrect	B	Require repair or replacement.
Application incorrect	B	Require repair or replacement.
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Components binding	A	Require repair or replacement.
Components damaged, affecting operation or performance	A	Require repair or replacement.
Components missing	C	Require replacement of components.
Contaminated	A	(1) Require repair or replacement. Further inspection required.
Controlling linkages binding	A	Require repair or replacement of linkage.
Leaking	A	Require repair or replacement.
Mechanical operation incorrect	B	Require repair or replacement.
Operating incorrectly	B	Require repair or replacement.

(1) - Some components may be serviceable; check for accepted cleaning procedure. Determine source of contamination, such as engine coolant, fuel, metal particles, or water. Require repair or replacement.

CASTING CORE PLUGS AND EXPANSION PLUGS

CASTING CORE PLUG AND EXPANSION PLUG INSPECTION

Condition	Code	Procedure
Leaking	A	Require replacement.
Material type incorrect	2	Suggest replacement.

CHARGE AIR COOLERS "INTERCOOLERS" (CAC)

CHARGE AIR COOLER "INTERCOOLER" (CAC) INSPECTION

Condition	Code	Procedure
Air-to-air intercooler leaking, affecting boost performance	A	Require repair or replacement.
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware		

missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Leaking coolant	A	Require repair or replacement.
Missing	C	Require replacement.
Restricted, affecting performance	A	Require repair or replacement.

CHECK VALVES

See ASPIRATOR, CHECK AND DECEL VALVES.

CHOKES

See CARBURETORS AND CHOKES.

CLUTCH PEDAL POSITION SWITCHES

CLUTCH PEDAL POSITION SWITCH INSPECTION

Condition	Code	Procedure
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware threads damaged	A	Require repair or replacement of hardware.
Attaching hardware threads stripped (threads missing)	A	Require repair or replacement of hardware.
Connector broken	A	Require repair or replacement.
Connector melted	A	(1) Require repair or replacement.
Connector missing	C	Require replacement.
Inoperative	B	(2) Require repair or replacement. Further inspection required.
Missing	C	Require replacement.
Resistance out of specification	B	Require repair or replacement.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(1) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.
Wire lead conductors		

exposed	B	.. Require repair or replacement.
Wire lead corroded	A	.. Require repair or replacement.
Wire lead open	A	.. Require repair or replacement.
Wire lead shorted	A	.. Require repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - Inoperative includes intermittent operation or out of OEM specification. Some components may be serviceable; check for accepted cleaning procedure.

COLD START INJECTORS

See FUEL AND COLD START INJECTORS.

CONNECTORS

See WIRING HARNESSES AND CONNECTORS.

COOLANT

COOLANT INSPECTION

Condition	Code	Procedure
Acidity (pH) incorrect ..	1	.... Suggest correction or replacement.
Contaminated	B	...... (1) Require replacement or recycling. Further inspection required.
Level low	B	... (2) Require filling to proper level.
Maintenance intervals ...	3	.... (3) Suggest replacement.
Mixture incorrect	B	.... Require correction or replacement.
Type incorrect	B	.... Require replacement.

(1) - Determine source of contamination and require correction prior to coolant replacement.
(2) - Determine source of incorrect level and suggest repair.
(3) - The system should be drained and/or flushed and refilled with correct coolant according to OEM recommended service interval and procedures.

COOLANT RECOVERY TANKS

COOLANT RECOVERY TANK INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	.. Require repair or replacement of hardware.
Attaching hardware missing	C	.... Require replacement of hardware.
Attaching hardware not functioning	A	.. Require repair or replacement of hardware.
Leaking	A	. Require repair or replacement.

Missing (if original equipment)	C	Require replacement.

COOLING FAN MOTOR MODULES

See COOLING FAN MOTOR RELAYS AND MODULES.

COOLING FAN MOTOR RELAYS AND MODULES

COOLING FAN MOTOR RELAY AND MODULE INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Connector broken	A	Require repair or replacement.
Connector (Weatherpack type) leaking	A	Require repair or replacement.
Connector melted	A	(1) Require repair or replacement.
Connector missing	C	Require replacement.
Housing cracked	2	Suggest repair or replacement.
Malfunctioning	A	(2) Require repair or replacement.
Missing	C	Require replacement.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(1) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.
Wire lead conductors exposed	B	Require repair or replacement.
Wire lead corroded	A	Require repair or replacement.
Wire lead open	A	Require repair or replacement.
Wire lead shorted	A	Require repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - Includes inoperative, intermittent operation, failure to perform all functions, or out of OEM specification.

COOLING FAN MOTOR RESISTORS

COOLING FAN MOTOR RESISTOR INSPECTION

Condition	Code	Procedure
Application incorrect	B	Require replacement.
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Connector broken	A	Require repair or replacement.
Connector (Weatherpack type) leaking	A	Require repair or replacement.
Connector melted	A	(1) Require repair or replacement.
Connector missing	C	Require replacement.
Missing	C	Require replacement.
Open	A	Require replacement.
Resistance out of specification	B	Require repair or replacement.
Shorted	A	Require replacement.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(1) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.

COOLING FAN MOTOR SENSORS AND SWITCHES

COOLING FAN MOTOR SENSOR AND SWITCH INSPECTION

Condition	Code	Procedure
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware threads damaged	A	Require repair or replacement of hardware.
Attaching hardware threads stripped (threads missing)	A	Require repair or replacement of hardware.
Connector broken	A	Require repair or replacement.
Connector melted	A	(1) Require repair or replacement.
Connector missing	C	Require replacement.
Contaminated	A	(2) Require repair or

		replacement.
Inoperative	B	(3) Require repair or replacement. Further inspection required.
Leaking	A	Require repair or replacement.
Missing	C	Require replacement.
Resistance out of specification	B	Require repair or replacement.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(1) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.
Wire lead conductors exposed	B	Require repair or replacement.
Wire lead corroded	A	Require repair or replacement.
Wire lead open	A	Require repair or replacement.
Wire lead shorted	A	Require repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - Determine source of contamination, such as engine coolant, fuel, metal particles, or water. Require repair or replacement.
(3) - Inoperative includes intermittent operation or out of OEM specification. Some components may be serviceable; check for accepted cleaning procedure.

COOLING FAN MOTOR SWITCHES

See COOLING FAN MOTOR SENSORS AND SWITCHES.

COOLING FAN MOTORS

COOLING FAN MOTOR INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Connector broken	A	Require repair or replacement.
Connector (Weatherpack type) leaking	A	Require repair or replacement.

Connector melted	A	(1) Require repair or replacement.
Connector missing	C	Require replacement.
Hydraulic fan motor leaking	A	Require repair or replacement.
Inoperative	A	(2) Require replacement.
Missing	C	Require replacement.
Noisy	2	Suggest replacement.
Rotation incorrect for application	B	Require repair or replacement.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(1) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.
Vibration	1	Suggest replacement.
Wire lead conductors exposed	B	Require repair or replacement.
Wire lead corroded	A	Require repair or replacement.
Wire lead open	A	Require repair or replacement.
Wire lead shorted	A	Require repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - Check fan motor/controls. Inoperative includes intermittent operation or out of OEM specification.

CRANKSHAFT POSITION SENSORS

CRANKSHAFT POSITION SENSOR INSPECTION

Condition	Code	Procedure
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware threads damaged	A	Require repair or replacement of hardware.
Attaching hardware threads stripped (threads missing)	A	Require repair or replacement of hardware.
Connector broken	A	Require repair or replacement.
Connector (Weatherpack type) leaking	A	Require repair or replacement.
Connector melted	A	(1) Require repair or replacement.
Connector missing	C	Require replacement.
Contaminated	A	Require repair or replacement.
Inoperative	B	Require repair or replacement. Further inspection required.
Leaking	A	Require repair or replacement.

Missing	C	.... Require replacement.
Resistance out of specification	B	.. Require repair or replacement.
Terminal broken	A	.. Require repair or replacement.
Terminal burned, affecting performance	A	.... (1) Require repair or replacement.
Terminal burned, not affecting performance ..	2	.. Suggest repair or replacement.
Terminal corroded, affecting performance ..	A	.. Require repair or replacement.
Terminal corroded, not affecting performance ..	2	.. Suggest repair or replacement.
Terminal loose, affecting performance	B	.. Require repair or replacement.
Terminal loose, not affecting performance ..	1	.. Suggest repair or replacement.
Threads damaged	A	.. Require repair or replacement.
Threads stripped (threads missing)	A	.... Require replacement.
Wire lead conductors exposed	B	.. Require repair or replacement.
Wire lead corroded	A	.. Require repair or replacement.
Wire lead open	A	.. Require repair or replacement.
Wire lead shorted	A	.. Require repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - Determine source of contamination, such as engine coolant, fuel, metal particles, or water. Require repair or replacement.
(3) - Inoperative includes intermittent operation or out of OEM specification. Some components may be serviceable; check for accepted cleaning procedure.

DECEL VALVES

See ASPIRATOR, CHECK AND DECEL VALVES.

DEFLECTORS

See SHROUDS, BAFFLES AND DEFLECTORS.

DIP STICKS AND TUBES

DIP STICK AND TUBE INSPECTION

Condition	Code	Procedure
Application incorrect ...	B	.... Require replacement.
Bent	2	.. Suggest repair or replacement.
Broken, affecting performance (for example, fuel mixture)	A	.. Require repair or replacement.
Broken, not affecting performance	2	.. Suggest repair or replacement.
Leaking, affecting performance (for example, fuel mixture)	A	.. Require repair or replacement.
Leaking, not affecting performance	2	.. Suggest repair or replacement.
Missing	C	Require replacement.

DIP STICK TUBES

See DIP STICKS AND TUBES.

DISTRIBUTOR ADVANCES AND RETARDERS (MECHANICAL AND VACUUM)

DISTRIBUTOR ADVANCE AND RETARDER (MECHANICAL AND VACUUM) INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Binding	A	Require repair or replacement.
Inoperative	A	(1) Require repair or replacement.
Leaking	A	Require replacement.
Out of specification	B	Require repair or replacement.

(1) - Inoperative includes intermittent operation.

DISTRIBUTOR BOOTS AND SHIELDS

DISTRIBUTOR BOOT AND SHIELD INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Deteriorated	A	Require replacement.
Leaking	A	Require replacement.
Missing	A	Require replacement.
Torn	A	Require replacement.

DISTRIBUTOR CAPS

DISTRIBUTOR CAP INSPECTION

Condition	Code	Procedure
Application incorrect	B	Require replacement.
Arcing	A	Require replacement.
Attaching hardware broken	A	Require repair or replacement of hardware.

Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Burned	A	Require replacement.
Carbon button missing	A	Require replacement.
Carbon button worn, affecting performance	A	Require replacement.
Carbon button worn, not affecting performance	1	Suggest replacement.
Carbon-tracked	A	Require replacement.
Cracked	A	Require replacement.
Loose	2	Suggest repair or replacement.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(1) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal eroded, affecting performance	A	Require repair or replacement.
Terminal eroded, not affecting performance	..	No service suggested or required.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.

DISTRIBUTOR RETARDERS (MECHANICAL AND VACUUM)

See DISTRIBUTOR ADVANCES AND RETARDERS (MECHANICAL AND VACUUM).

DISTRIBUTOR ROTORS

DISTRIBUTOR ROTOR INSPECTION

Condition	Code	Procedure
Application incorrect	B	Require replacement.
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Carbon-tracked	A	Require replacement.
Contact burned	A	Require replacement.
Corroded	1	Suggest replacement.

Eroded	1	Suggest replacement.
Loose	A	Require repair or replacement.
Out of specification	B	Require replacement.

DISTRIBUTOR SHIELDS

See DISTRIBUTOR BOOTS AND SHIELDS.

DISTRIBUTORS

DISTRIBUTOR INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Bushings worn, affecting performance	A	Require repair or replacement.
Bushings worn, not affecting performance	1	Suggest repair or replacement.
Cam lobes worn, affecting performance	A	Require repair or replacement.
Cam lobes worn, not affecting performance	1	Suggest repair or replacement.
Gear broken	A	Require repair or replacement.
Gear worn, affecting performance	A	Require replacement.
Gear worn, not affecting performance	..	No service suggested or required.
Integrated pickup triggering device loose	A	Require repair or replacement.
Integrated pickup triggering device magnetism incorrect	A	Require repair or replacement.
Leaking oil internally	A	Require repair or replacement.
Noisy	2	Suggest repair or replacement.
Pickup triggering device (reluctor) broken	A	Require repair or replacement.
Pickup triggering device (reluctor) loose	A	Require repair or replacement.
Pickup triggering device (reluctor) weak	A	Require repair or replacement.
Reluctor (pickup triggering device) broken	A	Require repair or replacement.
Reluctor (pickup triggering device) loose	A	Require repair or replacement.
Reluctor (pickup triggering device) weak	A	Require repair or replacement.
Shaft bent	A	Require replacement.
Thrust washer broken	A	Require repair or replacement.

Condition	Code	Procedure
Thrust washer missing ...	C	.. Require repair or replacement.
Thrust washer worn, affecting performance ..	A	.. Require repair or replacement.
Thrust washer worn, not affecting performance ..	1	.. Suggest repair or replacement.

EARLY FUEL EVAPORATION VALVES (HEAT RISER ASSEMBLIES)

EARLY FUEL EVAPORATION VALVE (HEAT RISER ASSEMBLY) INSPECTION

Condition	Code	Procedure
Broken	A	. Require replacement of affected parts.
Diaphragm inoperative ...	A	.... (1) Further inspection required.
Leaking	A	.. Require repair or replacement.
Noisy	2	.. Suggest repair or replacement.
Seized	A	. Require replacement of affected parts.
Spring broken	B	.... Require replacement of spring(s).
Spring inoperative	A	...... (2) Require replacement of spring(s).

(1) - Inoperative includes intermittent operation or out of OEM specification. If the inoperative diaphragm is separate from the heat riser, then require replacement of the inoperative diaphragm. If the inoperative diaphragm is part of the heat riser, then replace the heat riser.
(2) - Inoperative includes intermittent operation or out of OEM specification.

EGR COOLERS

See EGR PLATES AND COOLERS.

EGR EXHAUST MANIFOLD PASSAGES

See EGR INTAKE AND EXHAUST MANIFOLD PASSAGES.

EGR INTAKE AND EXHAUST MANIFOLD PASSAGES

EGR INTAKE AND EXHAUST MANIFOLD PASSAGE INSPECTION

Condition	Code	Procedure
Leaking	A	.. Require repair or replacement.
Restricted, affecting performance	A	.. Require repair or replacement.

EGR PLATES AND COOLERS

EGR PLATE AND COOLER INSPECTION

Condition	Code	Procedure
Leaking	A	.. Require repair or replacement.

Missing	C	Require replacement.
Restricted, affecting performance	A	Require repair or replacement.

ELECTRONIC SPARK CONTROL MODULES

ELECTRONIC SPARK CONTROL MODULE INSPECTION

Condition	Code	Procedure
Application incorrect	B	Require replacement.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware threads damaged	A	Require repair or replacement of hardware.
Attaching hardware threads stripped (threads missing)	A	Require repair or replacement of hardware.
Connector broken	A	Require repair or replacement.
Connector (Weatherpack type) leaking	A	Require repair or replacement.
Connector melted	A	(1) Require repair or replacement.
Connector missing	A	Require repair.
Contaminated	A	(2) Require repair or replacement.
Leaking	A	Require repair or replacement.
Malfunctioning	A	(3) Require repair or replacement.
Missing	C	Require replacement.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(1) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.
Wire lead conductors exposed	B	Require repair or replacement.
Wire lead corroded	A	Require repair or replacement.
Wire lead open	A	Require repair or replacement.
Wire lead shorted	A	Require repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - Determine source of contamination, such as engine coolant, fuel, metal particles, or water. Require repair or replacement of source.
(3) - Includes inoperative, intermittent operation, failure to

perform all functions, or out of OEM specification.

ELECTRONIC TRANSMISSION CONTROL DEVICES

ELECTRONIC TRANSMISSION CONTROL DEVICE INSPECTION

Condition	Code	Procedure
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware threads damaged	A	Require repair or replacement of hardware.
Attaching hardware threads stripped (threads missing)	A	Require repair or replacement of hardware.
Connector broken	A	Require repair or replacement.
Connector (Weatherpack type) leaking	A	Require repair or replacement.
Connector melted	A	(1) Require repair or replacement.
Connector missing	C	Require replacement.
Contaminated	A	(2) Require repair or replacement.
Leaking	A	Require repair or replacement.
Malfunctioning	A	(3) Require repair or replacement.
Missing	C	Require replacement.
Resistance out of specification	B	Require repair or replacement.
Restricted, affecting performance	A	Require repair or replacement.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(1) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.
Wire lead conductors exposed	B	Require repair or replacement.
Wire lead corroded	A	Require repair or replacement.
Wire lead open	A	Require repair or replacement.
Wire lead shorted	A	Require repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - Determine source of contamination, such as engine coolant, fuel, metal particles, or water. Require repair or replacement.

(3) - Includes inoperative, intermittent operation, failure to perform all functions, or out of OEM specification.

ELECTRONIC TRANSMISSION FEEDBACK DEVICES

ELECTRONIC TRANSMISSION FEEDBACK DEVICE INSPECTION

Condition	Code	Procedure
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware threads damaged	A	Require repair or replacement of hardware.
Attaching hardware threads stripped (threads missing)	A	Require repair or replacement of hardware.
Connector broken	A	Require repair or replacement.
Connector (Weatherpack type) leaking	A	Require repair or replacement.
Connector melted	A	(1) Require repair or replacement.
Connector missing	C	Require replacement.
Contaminated	A	(2) Require repair or replacement.
Inoperative	B	(3) Require repair or replacement. Further inspection required.
Leaking	A	Require repair or replacement.
Missing	C	Require replacement.
Resistance out of specification	B	Require repair or replacement.
Restricted, affecting performance	A	Require repair or replacement.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(1) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.
Wire lead conductors exposed	B	Require repair or replacement.
Wire lead corroded	A	Require repair or replacement.
Wire lead open	A	Require repair or replacement.
Wire lead shorted	A	Require repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - Determine source of contamination, such as engine coolant,

fuel, metal particles, or water. Require repair or replacement.

(3) - Inoperative includes intermittent operation or out of OEM specification. Some components may be serviceable; check for accepted cleaning procedure.

ENGINE COOLANT TEMPERATURE SENSORS

ENGINE COOLANT TEMPERATURE SENSOR INSPECTION

Condition	Code	Procedure
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware threads damaged	A	Require repair or replacement of hardware.
Attaching hardware threads stripped (threads missing)	A	Require repair or replacement of hardware.
Connector broken	A	Require repair or replacement.
Connector (Weatherpack type) leaking	A	Require repair or replacement.
Connector melted	A	(1) Require repair or replacement.
Connector missing	C	Require replacement.
Contaminated	A	(2) Require repair or replacement.
Inoperative	B	(3) Require repair or replacement. Further inspection required.
Leaking	A	Require repair or replacement.
Missing	C	Require replacement.
Resistance out of specification	B	Require repair or replacement.
Restricted, affecting performance	A	Require repair or replacement.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(1) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.
Wire lead conductors exposed	B	Require repair or replacement.
Wire lead corroded	A	Require repair or replacement.
Wire lead open	A	Require repair or replacement.
Wire lead shorted	A	Require repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - Determine source of contamination, such as engine coolant, fuel, metal particles, or water. Require repair or replacement.
(3) - Inoperative includes intermittent operation or out of OEM specification. Some components may be serviceable; check for accepted cleaning procedure.

ENGINE COOLING SYSTEMS

NOTE: Overheating, poor engine performance, and insufficient cabin heat can be affected by, but are not limited to, all of the components in the engine cooling system.

ENGINE COVERS (OIL PAN, VALVE COVER, TIMING COVER)

ENGINE COVER (OIL PAN, VALVE COVER, TIMING COVER) INSPECTION

Condition	Code	Procedure
Attaching hardware incorrect	B	Require replacement.
Attaching hardware loose	A	Require repair or replacement.
Attaching hardware missing	C	Require replacement.
Baffle loose	2	Suggest repair or replacement.
Baffle missing	C	Require replacement.
Bent, affecting performance	A	Require repair or replacement.
Bent, not affecting performance	..	No service suggested or required.
Cracked (not leaking)	2	Suggest repair or replacement.
Leaking externally	A	Require repair or replacement.
Leaking internally, causing fluid contamination	A	Require repair or replacement.
Missing	C	Require replacement.
Restricted passage	A	Require repair or replacement.
Threads damaged	A	Require repair or replacement.

ENGINE OIL

ENGINE OIL INSPECTION

Condition	Code	Procedure
Contaminated	A	(1) Require replacement of oil and filter.
Level high	B	Determine source of incorrect level and require repair.
Level low	B	Determine source of incorrect level and require repair.
Maintenance intervals	3	Suggest replacement to comply with vehicle's OEM recommended service intervals.

(1) - Determine source of contamination, such as engine coolant, fuel, metal particles, or water when changing oil. Require

repair or replacement.

ENGINE OIL CANISTERS

See ENGINE OIL FILTERS AND CANISTERS.

ENGINE OIL COOLERS (EXTERNAL)

ENGINE OIL COOLER (EXTERNAL) INSPECTION

Condition	Code	Procedure
Air flow restriction	A	.. Require repair or replacement.
Attaching hardware broken	A	... Require repair or replacement of hardware.
Attaching hardware missing	C	.... Require replacement of hardware.
Attaching hardware not functioning	A	... Require repair or replacement of hardware.
Bypassed	A	.. Require repair or replacement.
Connection leaking	A	.. Require repair or replacement.
Corroded	1	.. Suggest repair or replacement.
Fins damaged, affecting performance	A	.. Require repair or replacement.
Fins damaged, not affecting performance ..	2	.. Suggest repair or replacement.
Fluid flow restrictions .	A	.. Require repair or replacement.
Internal restrictions, affecting performance ..	A	.. Require repair or replacement.
Leaking	A	.. Require repair or replacement.
Missing	A	.... Require replacement.
Threads damaged	A	.. Require repair or replacement.
Threads stripped (threads missing)	A	.... Require replacement.

ENGINE OIL DRAIN PLUGS AND GASKETS

ENGINE OIL DRAIN PLUG AND GASKET INSPECTION

Condition	Code	Procedure
Leaking	A	.. Require repair or replacement.
Missing	C	.... Require replacement.
Threads damaged	A	.... (1) Require repair or replacement.

(1) - Some OEMs require replacement of drain plug gasket when removing drain plug. Inspect threads in oil pan for damage.

ENGINE OIL FILTERS AND CANISTERS

ENGINE OIL FILTER AND CANISTER INSPECTION

Condition	Code	Procedure
Bulged	A	.... (1) Require replacement.

		Further inspection required.
Canister attaching hardware broken	A	Require repair or replacement of hardware.
Canister attaching hardware loose	A	Require repair.
Canister attaching hardware missing	C	Require replacement.
Canister attaching hardware not functioning	A	Require repair or replacement of hardware.
Center tube collapsed	A	(2) Require replacement. Further inspection required.
Contaminated	A	(3) Require replacement of oil and filter.
Dented	2	(4) Suggest replacement. Further inspection required.
Leaking	A	Require repair or replacement.
Maintenance intervals	3	Suggest replacement to comply with vehicle's OEM recommended service intervals.

(1) - Inspect pressure relief valve.
(2) - Inspect bypass.
(3) - Determine cause of contamination, such as engine coolant, fuel, metal particles, or water when changing oil. Require repair or replacement.
(4) - Determine cause, such as broken motor mount.

ENGINE OIL GASKETS

See ENGINE OIL DRAIN PLUGS AND GASKETS.

ENGINE OIL PRESSURE GAUGES (MECHANICAL)

ENGINE OIL PRESSURE GAUGE (MECHANICAL) INSPECTION

Condition	Code	Procedure
Indicates out of range	B	(1) Further inspection required.
Inoperative	A	(2) Further inspection required.
Leaking	A	Require repair or replacement.
Reads inaccurately	2	Suggest repair or replacement.

(1) - Gauge may indicate problem with contaminated oil, level, pressure, or temperature, or problem with gauge.
(2) - Gauge may indicate problem with contaminated oil, level, pressure, or temperature, or problem with gauge. Inoperative includes intermittent operation, out of OEM specification, or out of range. Further inspection required to determine cause.

EVAPORATIVE EMISSION (EVAP) CANISTER FILTERS

EVAPORATIVE EMISSION (EVAP) CANISTER FILTER INSPECTION

Condition	Code	Procedure

Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Maintenance interval	3	Suggest replacement to comply with OEM recommended service interval.
Missing	C	Require replacement.
Restricted, affecting performance	A	Require replacement.
Restricted, not affecting performance	1	Suggest replacement.
Water-contaminated	A	Require replacement.

EVAPORATIVE EMISSION (EVAP) CANISTER PURGE DEVICES

EVAPORATIVE EMISSION (EVAP) CANISTER PURGE DEVICE INSPECTION

Condition	Code	Procedure
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware threads damaged	A	Require repair or replacement of hardware.
Attaching hardware threads stripped (threads missing)	A	Require repair or replacement of hardware.
Connector broken	A	Require repair or replacement.
Connector (Weatherpack type) leaking	A	Require repair or replacement.
Connector melted	A	(1) Require repair or replacement.
Connector missing	C	Require replacement.
Contaminated	A	(2) Require repair or replacement.
Inoperative	B	(3) Require repair or replacement. Further inspection required.
Leaking	A	Require repair or replacement.
Missing	C	Require replacement.
Resistance out of specification	B	Require repair or replacement.
Restricted, affecting performance	A	Require repair or replacement.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(1) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.

Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.
Wire lead conductors exposed	B	Require repair or replacement.
Wire lead corroded	A	Require repair or replacement.
Wire lead open	A	Require repair or replacement.
Wire lead shorted	A	Require repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - Determine source of contamination, such as engine coolant, fuel, metal particles, or water. Require repair or replacement.
(3) - Inoperative includes intermittent operation or out of OEM specification. Some components may be serviceable; check for accepted cleaning procedure.

EVAPORATIVE EMISSION (EVAP) CANISTERS

EVAPORATIVE EMISSION (EVAP) CANISTER INSPECTION

Condition	Code	Procedure
Inoperative	A	(1) Require repair or replacement.
Leaking	A	Require replacement.
Missing	C	Require replacement.
Saturated	A	Require replacement.

(1) - Inoperative includes intermittent operation or out of OEM specification.

EVAPORATIVE EMISSION (EVAP) FEEDBACK DEVICES

EVAPORATIVE EMISSION (EVAP) FEEDBACK DEVICE INSPECTION

Condition	Code	Procedure
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware threads damaged	A	Require repair or replacement of hardware.
Attaching hardware threads stripped (threads missing)	A	Require repair or replacement of hardware.
Connector broken	A	Require repair or replacement.
Connector (Weatherpack type) leaking	A	Require repair or replacement.
Connector melted	A	(1) Require repair or replacement.
Connector missing	C	Require replacement.
Contaminated	A	(2) Require repair or replacement.

Inoperative	B	(3) Require repair or replacement. Further inspection required.
Leaking	A	Require repair or replacement.
Missing	C	Require replacement.
Resistance out of specification	B	Require repair or replacement.
Restricted, affecting performance	A	Require repair or replacement.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(1) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.
Wire lead conductors exposed	B	Require repair or replacement.
Wire lead corroded	A	Require repair or replacement.
Wire lead open	A	Require repair or replacement.
Wire lead shorted	A	Require repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - Determine source of contamination, such as engine coolant, fuel, metal particles, or water. Require repair or replacement.
(3) - Inoperative includes intermittent operation or out of OEM specification. Some components may be serviceable; check for accepted cleaning procedure.

EXHAUST GAS RECIRCULATION DEVICES

EXHAUST GAS RECIRCULATION DEVICE INSPECTION

Condition	Code	Procedure
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware threads damaged	A	Require repair or replacement of hardware.
Attaching hardware threads stripped (threads missing)	A	Require repair or replacement of hardware.
Connector broken	A	Require repair or replacement.
Connector (Weatherpack type) leaking	A	Require repair or replacement.
Connector melted	A	(1) Require repair or replacement.

Connector missing	C	.... Require replacement.
Contaminated	A	.... (2) Require repair or replacement.
Inoperative	B	.... (3) Require repair or replacement. Further inspection required.
Leaking	A	.. Require repair or replacement.
Missing	C	.... Require replacement.
Resistance out of specification	B	.. Require repair or replacement.
Restricted, affecting performance	A	.. Require repair or replacement.
Restricted, not affecting performance	1	.. Suggest repair or replacement.
Terminal broken	A	.. Require repair or replacement.
Terminal burned, affecting performance	A	.... (1) Require repair or replacement.
Terminal burned, not affecting performance ..	2	.. Suggest repair or replacement.
Terminal corroded, affecting performance ..	A	.. Require repair or replacement.
Terminal corroded, not affecting performance ..	2	.. Suggest repair or replacement.
Terminal loose, affecting performance	B	.. Require repair or replacement.
Terminal loose, not affecting performance ..	1	.. Suggest repair or replacement.
Threads damaged	A	.. Require repair or replacement.
Threads stripped (threads missing)	A	.... Require replacement.
Wire lead conductors exposed	B	.. Require repair or replacement.
Wire lead corroded	A	.. Require repair or replacement.
Wire lead open	A	.. Require repair or replacement.
Wire lead shorted	A	.. Require repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - Determine source of contamination, such as engine coolant, fuel, metal particles, or water. Require repair or replacement.
(3) - Inoperative includes intermittent operation or out of OEM specification. Some components may be serviceable; check for accepted cleaning procedure.

EXHAUST GAS RECIRCULATION FEEDBACK DEVICES

EXHAUST GAS RECIRCULATION FEEDBACK DEVICE INSPECTION

Condition	Code	Procedure
Attaching hardware missing	C	.... Require replacement of hardware.
Attaching hardware threads damaged	A	... Require repair or replacement of hardware.
Attaching hardware threads stripped (threads missing)	A	... Require repair or replacement of hardware.

Connector broken	A	.. Require repair or replacement.
Connector (Weatherpack type) leaking	A	.. Require repair or replacement.
Connector melted	A	.... (1) Require repair or replacement.
Connector missing	C	.... Require replacement.
Contaminated	A	.... (2) Require repair or replacement.
Inoperative	B	.... (3) Require repair or replacement. Further inspection required.
Leaking	A	.. Require repair or replacement.
Missing	C	.... Require replacement.
Resistance out of specification	B	.. Require repair or replacement.
Restricted, affecting performance	A	.. Require repair or replacement.
Restricted, not affecting performance	1	.. Suggest repair or replacement.
Terminal broken	A	.. Require repair or replacement.
Terminal burned, affecting performance	A	.... (1) Require repair or replacement.
Terminal burned, not affecting performance ..	2	.. Suggest repair or replacement.
Terminal corroded, affecting performance ..	A	.. Require repair or replacement.
Terminal corroded, not affecting performance ..	2	.. Suggest repair or replacement.
Terminal loose, affecting performance	B	.. Require repair or replacement.
Terminal loose, not affecting performance ..	1	.. Suggest repair or replacement.
Threads damaged	A	.. Require repair or replacement.
Threads stripped (threads missing)	A	.... Require replacement.
Wire lead conductors exposed	B	.. Require repair or replacement.
Wire lead corroded	A	.. Require repair or replacement.
Wire lead open	A	.. Require repair or replacement.
Wire lead shorted	A	.. Require repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - Determine source of contamination, such as engine coolant, fuel, metal particles, or water. Require repair or replacement.
(3) - Inoperative includes intermittent operation or out of OEM specification. Some components may be serviceable; check for accepted cleaning procedure.

EXPANSION PLUGS

See CASTING CORE PLUGS AND EXPANSION PLUGS.

FAN CONTROL SENSORS

FAN CONTROL SENSOR INSPECTION

Condition	Code	Procedure
Attaching hardware		

missing	C	Require replacement of hardware.
Attaching hardware threads damaged	A	Require repair or replacement of hardware.
Attaching hardware threads stripped (threads missing)	A	Require repair or replacement of hardware.
Connector broken	A	Require repair or replacement.
Connector (Weatherpack type) leaking	A	Require repair or replacement.
Connector melted	A	(1) Require repair or replacement.
Connector missing	C	Require replacement.
Contaminated	A	(2) Require repair or replacement.
Inoperative	B	(3) Require repair or replacement. Further inspection required.
Leaking	A	Require repair or replacement.
Missing	C	Require replacement.
Resistance out of specification	B	Require repair or replacement.
Restricted, affecting performance	A	Require repair or replacement.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(1) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.
Wire lead conductors exposed	B	Require repair or replacement.
Wire lead corroded	A	Require repair or replacement.
Wire lead open	A	Require repair or replacement.
Wire lead shorted	A	Require repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - Determine source of contamination, such as engine coolant, fuel, metal particles, or water. Require repair or replacement.
(3) - Inoperative includes intermittent operation or out of OEM specification. Some components may be serviceable; check for accepted cleaning procedure.

FUEL

FUEL INSPECTION

Condition	Code	Procedure
Contaminated	B	(1) Require repair or replacement.
Fuel incorrect	B	(2) Require flushing of system.

(1) - Determine of source of contamination. Require repair or replacement.
(2) - If a fuel other than specification fuel is present in the system, the required service is to flush and fill with the correct fuel.

FUEL ACCUMULATORS AND DAMPERS

FUEL ACCUMULATOR AND DAMPER INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Connections leaking	A	Require repair or replacement.
Inoperative	A	(1) Require replacement.
Leaking	A	Require replacement.

(1) - Inoperative includes intermittent operation or out of OEM specification.

FUEL AND COLD START INJECTORS

NOTE: You are not required to replace injectors in sets. However, you may suggest replacement of all injectors for preventive maintenance.

FUEL AND COLD START INJECTOR INSPECTION

Condition	Code	Procedure
Application incorrect	B	Require replacement.
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Connector broken	A	Require repair or replacement.
Connector (Weatherpack type) leaking	A	Require repair or replacement.
Connector melted	A	(1) Require repair or replacement.
Connector missing	C	Require replacement.

Flow restricted	B	.. Require repair or replacement.
Inoperative	B	.... (2) Require repair or replacement. Further inspection required.
Leaking	A	.. Require repair or replacement.
Resistance out of specification	B	.... Require replacement.
Terminal broken	A	.. Require repair or replacement.
Terminal burned, affecting performance	A	.... (1) Require repair or replacement.
Terminal burned, not affecting performance ..	2	.. Suggest repair or replacement.
Terminal corroded, affecting performance ..	A	.. Require repair or replacement.
Terminal corroded, not affecting performance ..	2	.. Suggest repair or replacement.
Terminal loose, affecting performance	B	.. Require repair or replacement.
Terminal loose, not affecting performance ..	1	.. Suggest repair or replacement.
Threads damaged	A	.. Require repair or replacement.
Threads stripped (threads missing)	A	.... Require replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - Inoperative includes intermittent operation, out of OEM specification. Some components may be serviceable.

FUEL DAMPERS

See FUEL ACCUMULATORS AND DAMPERS.

FUEL DELIVERY CHECK VALVES

FUEL DELIVERY CHECK VALVE INSPECTION

Condition	Code	Procedure
Inoperative	A	.... (1) Require replacement.
Leaking externally	A	.. Require repair or replacement.
Missing	C	.... Require replacement.
Pressure leaking (bleeds down)	A	.. Require repair or replacement.

(1) - Inoperative includes intermittent operation or out of OEM specification.

FUEL DISTRIBUTORS (BOSCH CIS)

FUEL DISTRIBUTOR (BOSCH CIS) INSPECTION

Condition	Code	Procedure
Inoperative	A	.... (1) Require repair or replacement. Further inspection required.
Leaking	A	.. Require repair or replacement.
Out of specification	B	.. Require repair or replacement.
Restricted, affecting		

performance	A	(2) Require repair or replacement. Further inspection required.

(1) - Inoperative includes intermittent operation.
(2) - Some components may be serviceable; check for accepted cleaning procedure.

FUEL FILLER NECKS AND RESTRICTORS

FUEL FILLER NECK AND RESTRICTOR INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Leaking	A	Require repair or replacement.
Missing	C	Require replacement.
Restricted	2	Suggest repair or replacement.

FUEL FILTERS

FUEL FILTER INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Leaking	A	Require repair or replacement.
Maintenance interval	3	Suggest replacement to comply with OEM recommended service interval.
Missing	C	Require replacement.
Restricted, affecting performance	A	Require replacement.
Restricted, not affecting performance	1	Suggest replacement.
Water-contaminated	2	Suggest replacement.

FUEL INJECTORS

FUEL INJECTOR INSPECTION

Condition	Code	Procedure
Attaching hardware		

missing	C	Require replacement of hardware.
Attaching hardware threads damaged	A	Require repair or replacement of hardware.
Attaching hardware threads stripped (threads missing)	A	Require repair or replacement of hardware.
Connector broken	A	Require repair or replacement.
Connector (Weatherpack type) leaking	A	Require repair or replacement.
Connector melted	A	(1) Require repair or replacement.
Connector missing	C	Require replacement.
Contaminated	A	(2) Require repair or replacement.
Inoperative	B	(3) Require repair or replacement. Further inspection required.
Leaking	A	Require repair or replacement.
Missing	C	Require replacement.
Resistance out of specification	B	Require repair or replacement.
Restricted, affecting performance	A	Require repair or replacement.
Restricted, not affecting performance	2	Suggest repair or replacement.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(1) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.
Wire lead conductors exposed	B	Require repair or replacement.
Wire lead corroded	A	Require repair or replacement.
Wire lead open	A	Require repair or replacement.
Wire lead shorted	A	Require repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - Determine source of contamination, such as engine coolant, fuel, metal particles, or water. Require repair or replacement.
(3) - Inoperative includes intermittent operation or out of OEM specification. Some components may be serviceable; check for accepted cleaning procedure.

FUEL LEVEL SENDERS

FUEL LEVEL SENDER INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Inoperative	A	(1) Require repair or replacement.
Leaking	A	Require repair or replacement.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(2) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.
Wire lead conductors exposed	B	Require repair or replacement.
Wire lead corroded	A	Require repair or replacement.
Wire lead open	A	Require repair or replacement.
Wire lead shorted	A	Require repair or replacement.

(1) - Inoperative includes intermittent operation or out of OEM specification.
(2) - Determine cause and correct prior to repair or replacement of part.

FUEL PRESSURE REGULATORS

FUEL PRESSURE REGULATOR INSPECTION

Condition	Code	Procedure
Contaminated	2	(1) Suggest repair or replacement. Further inspection required.
Inoperative	B	(2) Require repair or replacement.
Leaking (internally or externally)	A	Require repair or replacement.
Pressure out of specification	B	Require repair or replacement.
Vapor bypass restricted	A	Require repair or replacement.

(1) - Some components may be serviceable; check for accepted cleaning procedure. Determine source of contamination. Require repair or replacement.

(2) - Inoperative includes intermittent operation or out of OEM specification.

FUEL PUMPS (IN-TANK AND EXTERNAL, ELECTRICAL OR MECHANICAL)

FUEL PUMP (IN-TANK AND EXTERNAL, ELECTRICAL OR MECHANICAL) INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Connector broken	A	Require repair or replacement.
Connector (Weatherpack type) leaking	A	Require repair or replacement.
Connector melted	A	(1) Require repair or replacement.
Connector missing	C	Require replacement.
Contaminated	A	(2) Require replacement.
Inoperative	A	(3) Require repair or replacement.
Leaking externally (includes pulsator)	A	Require repair or replacement.
Leaking internally (includes pulsator)	A	Require repair or replacement.
Noisy	2	Suggest repair or replacement.
Out of specification	B	Require repair or replacement.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(1) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.
Wire lead conductors exposed	B	Require repair or replacement.
Wire lead corroded	A	Require repair or replacement.
Wire lead open	A	Require repair or replacement.
Wire lead shorted	A	Require repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - Determine source of contamination. Require repair or replacement.
(3) - Inoperative includes intermittent operation.

FUEL RAILS

FUEL RAIL INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Contaminated	A	(1) Require replacement.
Leaking	A	Require repair or replacement.
Restricted	A	Require repair or replacement.
Rust-pitted	1	Suggest replacement.

(1) - Determine source of contamination. Require repair or replacement.

FUEL RESTRICTORS

See FUEL FILLER NECKS AND RESTRICTORS.

FUEL TANKS

FUEL TANK INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Baffles loose	A	Require repair or replacement.
Contaminated	A	(1) Require repair.
Corroded internally	A	Require repair or replacement.
Distorted, affecting performance	B	Require replacement.
Distorted, not affecting performance	..	No service suggested or required.
Leaking	A	Require repair or replacement.

(1) - Determine source of contamination. Require repair or replacement.

GAS CAPS

GAS CAP INSPECTION

Condition	Code	Procedure
Application incorrect ...	B	.... Require replacement.
Fails to maintain proper pressure	A	.... Require replacement.
Gaskets missing	C	.... Require replacement.
Leaking	A	.... Require replacement.
Missing	C	.... Require replacement.
Plugged (vacuum and pressure relief)	A	.... Require replacement.
Seals missing	C	.... Require replacement.

GASKETS

GASKET INSPECTION

Condition	Code	Procedure
Leaking	A	.... (1) Require repair or replacement.

(1) - Require inspection of mating and sealing surface and repair or replace as necessary.

GROMMETS (VALVE COVER)

GROMMET (VALVE COVER) INSPECTION

Condition	Code	Procedure
Leaking	2	.... (1) Suggest repair or replacement.

(1) - Require inspection of mating and sealing surface and repair or replace as necessary.

HARMONIC DAMPERS

HARMONIC DAMPER INSPECTION

Condition	Code	Procedure
Application incorrect ...	B	.... Require replacement.
Attaching hardware broken	A	.. Require repair or replacement of hardware.
Attaching hardware missing	C	.... Require replacement of hardware.
Attaching hardware not functioning	A	.. Require repair or replacement of hardware.
Cracked	A	.... Require replacement.
Dented (fluid type only)	A	.... Require replacement.
Keyway distorted	A	. Require repair or replacement.
Leaking (Fluid damper only)	A	.... Require replacement.
Loose	A	.... Require replacement.
Noisy	A	.... Require replacement.

Condition	Code	Procedure
Outer ring slipped out of position	A	Require replacement.
Positioned incorrectly	A	Require repair or replacement.
Rubber damping material deteriorated	1	Suggest replacement.
Seal surface worn, causing a leak	A	Require repair or replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.

HEATER CONTROL VALVES

HEATER CONTROL VALVE INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Bypassed	A	Require replacement.
Coolant leak	A	Require repair or replacement.
Malfunctioning	A	(1) Require repair or replacement.
Missing	C	Require replacement.
Restricted	A	Require repair or replacement.
Vacuum leak	A	Require repair or replacement.

(1) - Includes inoperative, intermittent operation, or failure to perform all functions.

HEATER CORES

HEATER CORE INSPECTION

Condition	Code	Procedure
Air flow restriction	A	Require repair or replacement.
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Bypassed	A	Require repair or replacement.
Connection leaking	A	Require repair or replacement.
Corroded	1	Suggest repair or replacement.
Fins damaged, affecting performance	A	Require repair or replacement.
Fins damaged, not affecting performance	2	Suggest repair or replacement.
Internal restrictions,		

Condition	Code	Procedure
affecting performance ..	A	.. Require repair or replacement.
Leaking	A	.. Require repair or replacement.
Missing	C	.... Require replacement.

HOSE AND TUBE COUPLERS, CONNECTORS AND CLAMPS

NOTE: When replacing fuel lines and hoses, replace with product that meets or exceeds OEM design specifications.

HOSE AND TUBE COUPLER, CONNECTOR AND CLAMP INSPECTION

Condition	Code	Procedure
Application incorrect ...	B	.... Require replacement.
Connected incorrectly ...	A	.... Require repair.
Corroded, not reusable ..	1	.... Suggest replacement.
Cracked	A	.... Require replacement.
Insufficient clamping force, allowing hose to leak	A	.. Require repair or replacement.
Leaking	A	.. Require repair or replacement.
Missing	C	.... Require replacement.
Safety clip missing (not leaking)	C	... Require replacement of safety clip.
Stripped	A	.... Require replacement.

HOSE CLAMPS

See HOSE AND TUBE COUPLERS, CONNECTORS AND CLAMPS.

HOSE CONNECTORS

See HOSE AND TUBE COUPLERS, CONNECTORS AND CLAMPS.

HOSE COUPLERS

See HOSE AND TUBE COUPLERS, CONNECTORS AND CLAMPS.

HOSES AND TUBES (FUEL LINES, RADIATOR, VACUUM, BY PASS, HEATER, RECOVERY TANK AND OIL COOLERS)

HOSE AND TUBE (FUEL LINE, RADIATOR, VACUUM, BY PASS, HEATER, RECOVERY TANK AND OIL COOLER) INSPECTION

Condition	Code	Procedure
Application incorrect ...	B	.... Require replacement.
Connected incorrectly ...	A	.... Require repair.
Corroded, not reusable ..	1	.... Suggest replacement.
Cracked	A	.... Require replacement.
Dry-rotted	1	.. Suggest repair or replacement.
Hard	1	.. Suggest repair or replacement.
Inner fabric (webbing) damaged	A	.... Require replacement.
Insufficient clamping force, allowing hose to leak	A	.. Require repair or replacement.
Leaking	A	.. Require repair or replacement.
Maintenance intervals ...	3	.... Suggest replacement.

Melted	1	Suggest repair or replacement.
Missing	C	Require replacement.
Outer covering damaged	1	Suggest replacement.
Outer covering damaged to the extent that the inner fabric is visible	A	Require replacement.
Protective sleeves damaged	2	Suggest replacement of sleeves.
Protective sleeves missing	2	Suggest replacement of sleeves.
Restricted, affecting performance	A	Require repair or replacement.
Restricted, not affecting performance	2	Suggest repair or replacement.
Routed incorrectly	2	Suggest repair or replacement.
Safety clip missing	C	Require replacement.
Spongy	1	Suggest repair or replacement.
Stripped	A	Require replacement.
Swollen	B	Require replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.
Type incorrect	1	Suggest repair or replacement.

HOUSINGS

See THERMOSTATS AND HOUSINGS.

IDLE AIR CONTROLS

IDLE AIR CONTROL INSPECTION

Condition	Code	Procedure
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware threads damaged	A	Require repair or replacement of hardware.
Attaching hardware threads stripped (threads missing)	A	Require repair or replacement of hardware.
Connector broken	A	Require repair or replacement.
Connector (Weatherpack type) leaking	A	Require repair or replacement.
Connector melted	A	(1) Require repair or replacement.
Connector missing	C	Require replacement.
Contaminated	A	(2) Require repair or replacement.
Inoperative	B	(3) Require repair or replacement. Further inspection required.
Leaking	A	Require repair or replacement.
Missing	C	Require replacement.
Resistance out of specification	B	Require repair or replacement.
Restricted, affecting performance	A	Require repair or replacement.
Terminal broken	A	Require repair or replacement.

Terminal burned, affecting performance	A	(1) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.
Wire lead conductors exposed	B	Require repair or replacement.
Wire lead corroded	A	Require repair or replacement.
Wire lead open	A	Require repair or replacement.
Wire lead shorted	A	Require repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - Determine source of contamination, such as engine coolant, fuel, metal particles, or water. Require repair or replacement.
(3) - Inoperative includes intermittent operation or out of OEM specification. Some components may be serviceable; check for accepted cleaning procedure.

IDLE SPEED CONTROL ACTUATORS

IDLE SPEED CONTROL ACTUATOR INSPECTION

Condition	Code	Procedure
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware threads damaged	A	Require repair or replacement of hardware.
Attaching hardware threads stripped (threads missing)	A	Require repair or replacement of hardware.
Connector broken	A	Require repair or replacement.
Connector (Weatherpack type) leaking	A	Require repair or replacement.
Connector melted	A	(1) Require repair or replacement.
Connector missing	C	Require replacement.
Contaminated	A	(2) Require repair or replacement.
Inoperative	B	(3) Require repair or replacement. Further inspection required.
Leaking	A	Require repair or replacement.
Missing	C	Require replacement.
Resistance out of specification	B	Require repair or replacement.

Terminal broken	A	.. Require repair or replacement.
Terminal burned, affecting performance	A	.... (1) Require repair or replacement.
Terminal burned, not affecting performance ..	2	.. Suggest repair or replacement.
Terminal corroded, affecting performance ..	A	.. Require repair or replacement.
Terminal corroded, not affecting performance ..	2	.. Suggest repair or replacement.
Terminal loose, affecting performance	B	.. Require repair or replacement.
Terminal loose, not affecting performance ..	1	.. Suggest repair or replacement.
Threads damaged	A	.. Require repair or replacement.
Threads stripped (threads missing)	A	.... Require replacement.
Wire lead conductors exposed	B	.. Require repair or replacement.
Wire lead corroded	A	.. Require repair or replacement.
Wire lead open	A	.. Require repair or replacement.
Wire lead shorted	A	.. Require repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - Determine source of contamination, such as engine coolant, fuel, metal particles, or water. Require repair or replacement.
(3) - Inoperative includes intermittent operation or out of OEM specification. Some components may be serviceable; check for accepted cleaning procedure.

IGNITION BOOTS

See
IGNITION WIRES, BOOTS, COIL TOWERS AND TERMINALS (SECONDARY) .

IGNITION COIL TOWERS

See
IGNITION WIRES, BOOTS, COIL TOWERS AND TERMINALS (SECONDARY) .

IGNITION COILS

IGNITION COIL INSPECTION

Condition	Code	Procedure
Arcing	A	.... Require replacement.
Attaching hardware broken	A	... Require repair or replacement of hardware.
Attaching hardware missing	C	.... Require replacement of hardware.
Attaching hardware not functioning	A	... Require repair or replacement of hardware.
Connector broken	A	.. Require repair or replacement.
Connector (Weatherpack type) leaking	A	.. Require repair or replacement.
Connector melted	A	.... (1) Require repair or

		replacement.
Connector missing	C	Require replacement.
Corroded, affecting performance	A	Require replacement.
Corroded, not affecting performance	2	Suggest replacement.
Distorted		(2) No service suggested or required.
Inoperative	A	(3) Require replacement.
Oil leaking	A	Require replacement.
Out of specification	B	Require replacement.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(1) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.
Wire lead conductors exposed	B	Require repair or replacement.
Wire lead corroded	A	Require repair or replacement.
Wire lead open	A	Require repair or replacement.
Wire lead shorted	A	Require repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - Distortion may be the result of overheating; coil should be tested.
(3) - Inoperative includes intermittent operation.

IGNITION CONTROL MODULES (ICM)

IGNITION CONTROL MODULE (ICM) INSPECTION

Condition	Code	Procedure
Application incorrect	B	Require replacement.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware threads damaged	A	Require repair or replacement of hardware.
Attaching hardware threads stripped (threads missing)	A	Require repair or replacement of hardware.
Code set (if applicable)	A	(1) Further inspection required.
Connector broken	A	Require repair or replacement.
Connector (Weatherpack type) leaking	A	Require repair or replacement.
Connector melted	A	(2) Require repair or replacement.

Connector missing	A	.... Require repair.
Contaminated	A	.... (3) Require repair or replacement.
Leaking	A	.. Require repair or replacement.
Malfunctioning	A	.... (4) Require repair or replacement.
Missing	C	.... Require replacement.
Terminal broken	A	.. Require repair or replacement.
Terminal burned, affecting performance	A	.... (2) Require repair or replacement.
Terminal burned, not affecting performance ..	2	.. Suggest repair or replacement.
Terminal corroded, affecting performance ..	A	.. Require repair or replacement.
Terminal corroded, not affecting performance ..	2	.. Suggest repair or replacement.
Terminal loose, affecting performance	B	.. Require repair or replacement.
Terminal loose, not affecting performance ..	1	.. Suggest repair or replacement.
Threads damaged	A	.. Require repair or replacement.
Wire lead conductors exposed	B	.. Require repair or replacement.
Wire lead corroded	A	.. Require repair or replacement.
Wire lead open	A	.. Require repair or replacement.
Wire lead shorted	A	.. Require repair or replacement.

(1) - Refer to manufacturer's diagnostic trouble code procedure and require repair or replacement of affected component(s).
(2) - Determine cause and correct prior to repair or replacement of part.
(3) - Determine source of contamination, such as engine coolant, fuel, metal particles, or water. Require repair or replacement.
(4) - Includes inoperative, intermittent operation, or failure to perform all functions.

IGNITION SWITCHES

See SWITCHES.

IGNITION TERMINALS

See
IGNITION WIRES, BOOTS, COIL TOWERS AND TERMINALS (SECONDARY).

IGNITION WIRES, BOOTS, COIL TOWERS AND TERMINALS (SECONDARY)

NOTE: You are not required to replace ignition wires in sets. However, you may suggest replacement of the entire secondary wire set for preventive maintenance.

IGNITION WIRE, BOOT, COIL TOWER AND TERMINAL (SECONDARY) INSPECTION

Condition	Code	Procedure
Application incorrect ...	B	.... Require replacement.
Attaching hardware broken	A	... Require repair or replacement of hardware.

Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Carbon-tracked	A	Require replacement.
Corroded	1	Suggest repair or replacement.
Insulation leaking (shorted)	A	Require repair or replacement.
Metal heat shield bent	2	Suggest repair or replacement.
Missing	C	Require replacement.
Oil-soaked (spongy)	1	Suggest replacement.
Resistance incorrect	B	Require replacement.
Routed incorrectly	2	(1) Suggest repair.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(2) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.

(1) - If improper routing affects the performance of other systems, require repair. Proper routing, hardware, heatshields, etc., are intended to prevent premature failure of secondary ignition components.
(2) - Determine cause and correct prior to repair or replacement of part.

IN-TANK FUEL STRAINERS

IN-TANK FUEL STRAINER INSPECTION

Condition	Code	Procedure
Missing	C	Require replacement.
Restricted	A	Require repair or replacement.
Torn	A	Require replacement.

INERTIA FUEL SHUT-OFF SWITCHES

INERTIA FUEL SHUT-OFF SWITCH INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement

		of hardware.
Connector broken	A	Require repair or replacement.
Connector melted	A	(1) Require repair or replacement.
Connector missing	C	Require replacement.
Contaminated	A	(2) Require replacement.
Inoperative	A	(3) Require repair or replacement.
Missing	C	Require replacement.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(1) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.
Wire lead conductors exposed	B	Require repair or replacement.
Wire lead corroded	A	Require repair or replacement.
Wire lead open	A	Require repair or replacement.
Wire lead shorted	A	Require repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - Determine source of contamination, such as engine coolant, fuel, metal particles, or water. Require repair or replacement.
(3) - Inoperative includes intermittent operation or out of OEM specification.

INTAKE AIR TEMPERATURE SENSORS

INTAKE AIR TEMPERATURE SENSOR INSPECTION

Condition	Code	Procedure
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware threads damaged	A	Require repair or replacement of hardware.
Attaching hardware threads stripped (threads missing)	A	Require repair or replacement of hardware.
Connector broken	A	Require repair or replacement.
Connector (Weatherpack type) leaking	A	Require repair or replacement.
Connector melted	A	(1) Require repair or replacement.
Connector missing	C	Require replacement.
Contaminated	A	(2) Require repair or replacement.
Inoperative	B	(3) Require repair or

		replacement. Further inspection required.
Leaking	A	Require repair or replacement.
Missing	C	Require replacement.
Resistance out of specification	B	Require repair or replacement.
Restricted, affecting performance	A	Require repair or replacement.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(1) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.
Wire lead conductors exposed	B	Require repair or replacement.
Wire lead corroded	A	Require repair or replacement.
Wire lead open	A	Require repair or replacement.
Wire lead shorted	A	Require repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - Determine source of contamination, such as engine coolant, fuel, metal particles, or water. Require repair or replacement.
(3) - Inoperative includes intermittent operation or out of OEM specification. Some components may be serviceable; check for accepted cleaning procedure.

INTAKE MANIFOLDS

INTAKE MANIFOLD INSPECTION

Condition	Code	Procedure
Corroded, affecting sealability	A	Require repair or replacement.
Integrated air or fuel control components inoperative	A	(1) Require repair or replacement.
Internal air or fuel components damaged, affecting performance	A	Require repair or replacement of component.
Internal air or fuel components damaged, not affecting performance	..	No service suggested or required.
Internal air or fuel components missing	C	Require replacement of

		component.
Leaking	A	Require repair or replacement.
Out of specification	B	Require replacement.
Restricted	A	Require repair or replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require repair or replacement.
Warped	B	Require repair or replacement.

(1) - Inoperative includes intermittent operation or out of OEM specification.

INTERCOOLERS

See CHARGE AIR COOLERS "INTERCOOLERS" (CAC).

KNOCK SENSORS

KNOCK SENSOR INSPECTION

Condition	Code	Procedure
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware threads damaged	A	Require repair or replacement of hardware.
Attaching hardware threads stripped (threads missing)	A	Require repair or replacement of hardware.
Connector broken	A	Require repair or replacement.
Connector (Weatherpack type) leaking	A	Require repair or replacement.
Connector melted	A	(1) Require repair or replacement.
Connector missing	C	Require replacement.
Inoperative	B	(2) Require repair or replacement. Further inspection required.
Leaking	A	Require repair or replacement.
Missing	C	Require replacement.
Resistance out of specification	B	Require repair or replacement.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(1) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.

Wire lead conductors exposed	B	Require repair or replacement.
Wire lead corroded	A	Require repair or replacement.
Wire lead open	A	Require repair or replacement.
Wire lead shorted	A	Require repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - Inoperative includes intermittent operation or out of OEM specification. Some components may be serviceable; check for accepted cleaning procedure.

LIQUID VAPOR SEPARATORS

LIQUID VAPOR SEPARATOR INSPECTION

Condition	Code	Procedure
Inoperative	A	(1) Require repair or replacement.
Leaking	A	Require replacement.
Missing	C	Require replacement.
Restricted	A	Require repair or replacement.

(1) - Inoperative includes intermittent operation or out of OEM specification.

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSORS

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR INSPECTION

Condition	Code	Procedure
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware threads damaged	A	Require repair or replacement of hardware.
Attaching hardware threads stripped (threads missing)	A	Require repair or replacement of hardware.
Connector broken	A	Require repair or replacement.
Connector (Weatherpack type) leaking	A	Require repair or replacement.
Connector melted	A	(1) Require repair or replacement.
Connector missing	C	Require replacement.
Contaminated	A	(2) Require repair or replacement.
Inoperative	B	(3) Require repair or replacement. Further inspection required.
Leaking	A	Require repair or replacement.
Missing	C	Require replacement.
Resistance out of specification	B	Require repair or replacement.
Restricted, affecting performance	A	Require repair or replacement.
Terminal broken	A	Require repair or replacement.

Terminal burned, affecting performance	A	(1) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.
Wire lead conductors exposed	B	Require repair or replacement.
Wire lead corroded	A	Require repair or replacement.
Wire lead open	A	Require repair or replacement.
Wire lead shorted	A	Require repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - Determine source of contamination, such as engine coolant, fuel, metal particles, or water. Require repair or replacement.
(3) - Inoperative includes intermittent operation or out of OEM specification. Some components may be serviceable; check for accepted cleaning procedure.

MASS AIR FLOW (MAF) SENSORS

MASS AIR FLOW (MAF) SENSOR INSPECTION

Condition	Code	Procedure
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware threads damaged	A	Require repair or replacement of hardware.
Attaching hardware threads stripped (threads missing)	A	Require repair or replacement of hardware.
Connector broken	A	Require repair or replacement.
Connector (Weatherpack type) leaking	A	Require repair or replacement.
Connector melted	A	(1) Require repair or replacement.
Connector missing	C	Require replacement.
Contaminated	A	(2) Require repair or replacement.
Inoperative	B	(3) Require repair or replacement. Further inspection required.
Leaking	A	Require repair or replacement.
Missing	C	Require replacement.
Resistance out of specification	B	Require repair or replacement.

Restricted, affecting performance	A	Require repair or replacement.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(1) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.
Wire lead conductors exposed	B	Require repair or replacement.
Wire lead corroded	A	Require repair or replacement.
Wire lead open	A	Require repair or replacement.
Wire lead shorted	A	Require repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - Determine source of contamination, such as engine coolant, fuel, metal particles, or water. Require repair or replacement.
(3) - Inoperative includes intermittent operation or out of OEM specification. Some components may be serviceable; check for accepted cleaning procedure.

METAL AIR MANIFOLDS AND PIPES

METAL AIR MANIFOLD AND PIPE INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Broken	A	Require repair of injection tube or replacement of manifold.
Corroded, affecting structural integrity	1	Suggest replacement of injection tube or manifold.
Leaking	A	Require repair of injection tube or replacement of manifold.
Loose	A	Require repair.
Missing	C	Require replacement.
Restricted	A	Require replacement of injection tube or manifold.

Threads damaged	A	Require repair.
Threads stripped (threads missing)	A	Require replacement.

METAL AIR PIPES

See METAL AIR MANIFOLDS AND PIPES.

MIX CONTROL SOLENOIDS

MIX CONTROL SOLENOID INSPECTION

Condition	Code	Procedure
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware threads damaged	A	Require repair or replacement of hardware.
Attaching hardware threads stripped (threads missing)	A	Require repair or replacement of hardware.
Connector broken	A	Require repair or replacement.
Connector (Weatherpack type) leaking	A	Require repair or replacement.
Connector melted	A	(1) Require repair or replacement.
Connector missing	C	Require replacement.
Contaminated	A	(2) Require repair or replacement.
Inoperative	B	(3) Require repair or replacement. Further inspection required.
Leaking	A	Require repair or replacement.
Missing	C	Require replacement.
Resistance out of specification	B	Require repair or replacement.
Restricted, affecting performance	A	Require repair or replacement.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(1) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.
Wire lead conductors exposed	B	Require repair or replacement.
Wire lead corroded	A	Require repair or replacement.
Wire lead open	A	Require repair or replacement.

Wire lead shorted	A	Require repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - Determine source of contamination, such as engine coolant, fuel, metal particles, or water. Require repair or replacement.
(3) - Inoperative includes intermittent operation or out of OEM specification. Some components may be serviceable; check for accepted cleaning procedure.

MOTOR MOUNTS

MOTOR MOUNT INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Broken	A	Require replacement.
Leaking (hydraulic mount)	A	Require replacement.
Mounting hole worn, affecting performance	A	Require replacement.
Mounting hole worn, not affecting performance	..	No service suggested or required.
Rubber deteriorated, affecting performance	A	Require replacement.
Rubber deteriorated, not affecting performance	..	No service suggested or required.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.

O-RINGS, GASKETS, SEALS AND SPRING LOCKS

O-RING, GASKET, SEAL AND SPRING LOCK INSPECTION

Condition	Code	Procedure
Leaking	A	(1) Require repair or replacement.

(1) - Require inspection of mating and sealing surface and repair or replace as necessary.

O2 SENSORS

O2 SENSOR INSPECTION

Condition	Code	Procedure

Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware threads damaged	A	Require repair or replacement of hardware.
Attaching hardware threads stripped (threads missing)	A	Require repair or replacement of hardware.
Connector broken	A	Require repair or replacement.
Connector (Weatherpack type) leaking	A	Require repair or replacement.
Connector melted	A	(1) Require repair or replacement.
Connector missing	C	Require replacement.
Contaminated	A	(2) Require repair or replacement.
Inoperative	B	(3) Require repair or replacement. Further inspection required.
Leaking	A	Require repair or replacement.
Missing	C	Require replacement.
Resistance out of specification	B	Require repair or replacement.
Restricted, affecting performance	A	Require repair or replacement.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(1) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.
Wire lead conductors exposed	B	Require repair or replacement.
Wire lead corroded	A	Require repair or replacement.
Wire lead open	A	Require repair or replacement.
Wire lead shorted	A	Require repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - Determine source of contamination, such as engine coolant, fuel, metal particles, or water. Require repair or replacement.
(3) - Inoperative includes intermittent operation or out of OEM specification. Some components may be serviceable; check for accepted cleaning procedure.

OIL PRESSURE SENDING UNITS

OIL PRESSURE SENDING UNIT INSPECTION

Condition	Code	Procedure
Connector broken	A	.. Require repair or replacement.
Connector (Weatherpack type) leaking	A	.. Require repair or replacement.
Connector melted	A	.... (1) Require repair or replacement.
Connector missing	C	.... Require replacement.
Inoperative	A	.... (2) Require repair or replacement.
Leaking	A	.... Require replacement.
Output signal incorrect .	B	.. Require repair or replacement.
Terminal broken	A	.. Require repair or replacement.
Terminal burned, affecting performance	A	.... (1) Require repair or replacement.
Terminal burned, not affecting performance ..	2	.. Suggest repair or replacement.
Terminal corroded, affecting performance ..	A	.. Require repair or replacement.
Terminal corroded, not affecting performance ..	2	.. Suggest repair or replacement.
Terminal loose, affecting performance	B	.. Require repair or replacement.
Terminal loose, not affecting performance ..	1	.. Suggest repair or replacement.
Threads damaged	A	.. Require repair or replacement.
Threads stripped (threads missing)	A	.... Require replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - Inoperative includes intermittent operation or out of OEM specification.

OIL PUMP PICK-UP SCREENS

OIL PUMP PICK-UP SCREEN INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	... Require repair or replacement of hardware.
Attaching hardware missing	C	.... Require replacement of hardware.
Attaching hardware not functioning	A	... Require repair or replacement of hardware.
Bypass stuck	A	.. Require repair or replacement.
Cracked	A	.. Require repair or replacement.
Loose	A	.. Require repair or replacement.
Missing	C	.... Require replacement.
Positioned incorrectly ..	A	.. Require repair or replacement.
Restricted	A	.. Require repair or replacement.
Screen torn	A	.... Require replacement.

OIL PUMPS

OIL PUMP INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Broken	A	Require repair or replacement.
Housing cracked	A	Require repair or replacement.
Leaking	A	Require repair or replacement.
Pressure relief valve stuck	A	Require repair or replacement.
Seized	A	Require repair or replacement.
Worn beyond specifications	B	Require repair or replacement.

PARK NEUTRAL POSITION SWITCHES

PARK NEUTRAL POSITION SWITCH INSPECTION

Condition	Code	Procedure
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware threads damaged	A	Require repair or replacement of hardware.
Attaching hardware threads stripped (threads missing)	A	Require repair or replacement of hardware.
Connector broken	A	Require repair or replacement.
Connector (Weatherpack type) leaking	A	Require repair or replacement.
Connector melted	A	(1) Require repair or replacement.
Connector missing	C	Require replacement.
Contaminated	A	(2) Require repair or replacement.
Inoperative	B	(3) Require repair or replacement. Further inspection required.
Leaking	A	Require repair or replacement.
Missing	C	Require replacement.
Resistance out of specification	B	Require repair or replacement.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(1) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.

Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.
Wire lead conductors exposed	B	Require repair or replacement.
Wire lead corroded	A	Require repair or replacement.
Wire lead open	A	Require repair or replacement.
Wire lead shorted	A	Require repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - Determine source of contamination, such as engine coolant, fuel, metal particles, or water. Require repair or replacement.
(3) - Inoperative includes intermittent operation or out of OEM specification. Some components may be serviceable; check for accepted cleaning procedure.

PCV BREATHER ELEMENTS

PCV BREATHER ELEMENT INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Leaking	A	Require replacement.
Maintenance intervals	3	Suggest replacement to comply with vehicle's OEM recommended service intervals.
Melted	A	Required replacement.
Missing	C	Require replacement.
Restricted, affecting performance	A	Require replacement.
Restricted, not affecting performance	1	Suggest replacement.
Water-contaminated	A	Require replacement.

PCV ORIFICES

PCV ORIFICE INSPECTION

Condition	Code	Procedure
Leaking	A	Require replacement.
Maintenance interval	3	Suggest repair or replacement to comply with OEM recommended service intervals.

Missing	C	Require replacement.
Restricted	A	Require repair or replacement.

PCV VALVES

PCV VALVE INSPECTION

Condition	Code	Procedure
Application incorrect	B	Require replacement.
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Grommet broken	A	Require repair or replacement of grommet.
Grommet missing	C	Require replacement of grommet.
Grommet not functioning	A	Require repair or replacement of grommet.
Inoperative	A	(1) Require replacement.
Leaking	A	Require replacement.
Maintenance interval	3	Suggest replacement to comply with vehicle's OEM recommended service intervals.
Missing	C	Require replacement.
Restricted	A	Require replacement.

(1) - Inoperative includes intermittent operation or out of OEM specification.

PICK-UP ASSEMBLIES (INCLUDES MAGNETIC, HALL EFFECT AND OPTICAL)

PICK-UP ASSEMBLY (MAGNETIC, HALL EFFECT AND OPTICAL) INSPECTION

Condition	Code	Procedure
Adjustment incorrect	B	Require repair.
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Connector broken	A	Require repair or replacement.
Connector (Weatherpack type) leaking	A	Require repair or replacement.
Connector melted	A	(1) Require repair or replacement.
Connector missing	C	Require replacement.
Inoperative	B	(2) Require replacement.
Oil-soaked	A	Require replacement.

Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(1) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.
Wire lead conductors exposed	B	Require repair or replacement.
Wire lead corroded	A	Require repair or replacement.
Wire lead open	A	Require repair or replacement.
Wire lead shorted	A	Require repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - Inoperative includes intermittent operation or out of OEM specification. Refer to OEM recommended service' procedures.

POWER STEERING PRESSURE SENSORS

POWER STEERING PRESSURE SENSOR INSPECTION

Condition	Code	Procedure
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware threads damaged	A	Require repair or replacement of hardware.
Attaching hardware threads stripped (threads missing)	A	Require repair or replacement of hardware.
Connector broken	A	Require repair or replacement.
Connector (Weatherpack type) leaking	A	Require repair or replacement.
Connector melted	A	(1) Require repair or replacement.
Connector missing	C	Require replacement.
Contaminated	A	(2) Require repair or replacement.
Inoperative	B	(3) Require repair or replacement. Further inspection required.
Leaking	A	Require repair or replacement.
Missing	C	Require replacement.
Resistance out of specification	B	Require repair or replacement.
Restricted, affecting performance	A	Require repair or replacement.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(1) Require repair or

		replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.
Wire lead conductors exposed	B	Require repair or replacement.
Wire lead corroded	A	Require repair or replacement.
Wire lead open	A	Require repair or replacement.
Wire lead shorted	A	Require repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - Determine source of contamination, such as engine coolant, fuel, metal particles, or water. Require repair or replacement.
(3) - Inoperative includes intermittent operation or out of OEM specification. Some components may be serviceable; check for accepted cleaning procedure.

POWERTRAIN CONTROL MODULES (PCM) AND PROM

POWERTRAIN CONTROL MODULE (PCM) AND PROM INSPECTION

Condition	Code	Procedure
Application incorrect	B	Require replacement.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware threads damaged	A	Require repair or replacement of hardware.
Attaching hardware threads stripped (threads missing)	A	Require repair or replacement of hardware.
Code set (if applicable)	A	(1) Further inspection required.
Connector broken	A	Require repair or replacement.
Connector (Weatherpack type) leaking	A	Require repair or replacement.
Connector melted	A	(2) Require repair or replacement.
Connector missing	A	Require repair.
Contaminated	A	(3) Require repair or replacement.
Leaking	A	Require repair or replacement.
Malfunctioning	A	(4) Require repair or replacement.
Missing	C	Require replacement.
Terminal broken	A	Require repair or replacement.

Condition	Code	Procedure
Terminal burned, affecting performance	A	(2) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.
Wire lead conductors exposed	B	Require repair or replacement.
Wire lead corroded	A	Require repair or replacement.
Wire lead open	A	Require repair or replacement.
Wire lead shorted	A	Require repair or replacement.

(1) - Refer to manufacturer's diagnostic trouble code procedure and require repair or replacement of affected component(s).
(2) - Determine cause and correct prior to repair or replacement of part.
(3) - Determine source of contamination, such as engine coolant, fuel, metal particles, or water. Require repair or replacement.
(4) - Includes inoperative, intermittent operation, failure to perform all functions, or out of OEM specification.

POWERTRAIN CONTROL PROM

See POWERTRAIN CONTROL MODULES (PCM) AND PROM.

PRESSURIZED EXPANSION TANK CAPS

See RADIATOR CAPS AND PRESSURIZED EXPANSION TANK CAPS.

RADIATOR CAPS AND PRESSURIZED EXPANSION TANK CAPS

RADIATOR CAP AND PRESSURIZED EXPANSION TANK CAP INSPECTION

Condition	Code	Procedure
Application incorrect	B	Require replacement.
Coolant recovery check valve inoperative	A	(1) Require replacement.
Fails to maintain proper pressure	B	Require replacement.
Gasket missing	C	Require replacement of gasket.
Missing	C	Require replacement.
Seal missing	C	Require replacement of seal.

(1) - Inoperative includes intermittent operation or out of OEM specification.

RADIATOR FAN BLADES

RADIATOR FAN BLADE INSPECTION

Condition	Code	Procedure
Application incorrect ...	B	.... Require replacement.
Attaching hardware broken	A	.. Require repair or replacement of hardware.
Attaching hardware missing	C	.... Require replacement of hardware.
Attaching hardware not functioning	A	.. Require repair or replacement of hardware.
Bent	A	.... Require replacement.
Broken	A	.... Require replacement.
Cracked	A	.... Require replacement.
Loose	A	. Require repair or replacement.
Missing	C	.... Require replacement.

RADIATOR FAN CLUTCHES

NOTE: Some lateral movement, measured at the fan blade tip, may be normal.

RADIATOR FAN CLUTCH INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	... Require repair or replacement of hardware.
Attaching hardware missing	C	.... Require replacement of hardware.
Attaching hardware not functioning	A	... Require repair or replacement of hardware.
Bearing noisy	A	.... Require replacement.
Bearing worn	A	.... Require replacement.
Fastener loose	A	... Require repair or replacement of fastener.
Inoperative	A	.... (1) Require replacement.
Leaking	1	.... Suggest replacement.
Seized	A	.... Require replacement.
Slips (insufficient fan speed)	A	.... Require replacement.
Thermal control incorrect	B	.. Require repair or replacement.

(1) - Inoperative includes intermittent operation or out of OEM specification.

RADIATORS

RADIATOR INSPECTION

Condition	Code	Procedure
Air flow restriction	A	.... Require repair.

Application incorrect ...	B	.... Require replacement.
Attaching hardware broken	A	... Require repair or replacement of hardware.
Attaching hardware missing	C	.... Require replacement of hardware.
Attaching hardware not functioning	A	.. Require repair or replacement of hardware.
Connection leaking	A	.. Require repair or replacement.
Corroded	1	.. Suggest repair or replacement.
Fins damaged, affecting performance	A	.. Require repair or replacement.
Fins damaged, not affecting performance ..	2	.. Suggest repair or replacement.
Internal oil cooler leaking	A	.. Require repair or replacement.
Internal restrictions, affecting performance ..	B	.. Require repair or replacement.
Internal restrictions, not affecting performance ..	2	.. Suggest repair or replacement.
Leaking	A	.. Require repair or replacement.
Threads damaged	A	.. Require repair or replacement.
Threads stripped (threads missing)	A	.. Require repair or replacement.
Tubes damaged, affecting performance	A	.. Require repair or replacement.
Tubes damaged, not affecting performance ..	..	.... No service suggested or required.

ROLL OVER VALVES

ROLL OVER VALVE INSPECTION

Condition	Code	Procedure
Inoperative	A	.... (1) Require replacement.
Leaking	A	.... Require replacement.
Missing	C	.... Require replacement.

(1) - Inoperative includes intermittent operation or out of OEM specification.

SEALING COMPOUNDS

SEALING COMPOUND INSPECTION

Condition	Code	Procedure
Leaking	A	.... (1) Require repair or replacement.

(1) - Require inspection of mating and sealing surface and repair or replace as necessary.

SEALS

SEAL INSPECTION

Condition	Code	Procedure
Leaking	A	(1) Require repair or replacement.

(1) - Require inspection of mating and sealing surface and repair or replace as necessary.

SECONDARY AIR INJECTION SYSTEM MANAGEMENT DEVICES

SECONDARY AIR INJECTION SYSTEM MANAGEMENT DEVICE INSPECTION

Condition	Code	Procedure
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware threads damaged	A	Require repair or replacement of hardware.
Attaching hardware threads stripped (threads missing)	A	Require repair or replacement of hardware.
Connector broken	A	Require repair or replacement.
Connector (Weatherpack type) leaking	A	Require repair or replacement.
Connector melted	A	(1) Require repair or replacement.
Connector missing	C	Require replacement.
Contaminated	A	(2) Require repair or replacement.
Inoperative	B	(3) Require repair or replacement. Further inspection required.
Leaking	A	Require repair or replacement.
Missing	C	Require replacement.
Resistance out of specification	B	Require repair or replacement.
Restricted, affecting performance	A	Require repair or replacement.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(1) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.
Wire lead conductors exposed	B	Require repair or replacement.
Wire lead corroded	A	Require repair or replacement.

Wire lead open	A	..	Require repair or replacement.
Wire lead shorted	A	..	Require repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - Determine source of contamination, such as engine coolant, fuel, metal particles, or water. Require repair or replacement.
(3) - Inoperative includes intermittent operation or out of OEM specification. Some components may be serviceable; check for accepted cleaning procedure.

SENSORS AND ACTUATORS

NOTE: Conditions pertaining to the sensors and actuators listed in this section may be found under the name of the sensor or actuator.

SENSOR ABBREVIATION TABLE

Sensor	Abbreviation
Accelerator Pedal Position Sensor	APP
Air Conditioning Cycling Switch	AC
Air Conditioning Pressure Sensor	..
Air Fuel Ratio Sensor	..
Barometric Pressure Sensor	BARO
Camshaft Position Sensor	CMP
Clutch Pedal Position Switch	CPP
Cooling Fan Motor Sensors and Switches	..
Crankshaft Position Sensor	CKP
Electronic Transmission Feedback Devices	..
Engine Coolant Temperature Sensor	ECT
Evaporative Emission feedback devices	..
Exhaust Gas Recirculation feedback devices	..
Fan Control Sensor	FC
Intake Air Temperature Sensor	IAT
Knock Sensor	KS
Manifold Absolute Pressure Sensor	MAP
Mass Air Flow Sensor	MAF
O2 Sensor	O2S
Park Neutral Position Switch	PNP
Power Steering Pressure Sensor	PSP
Thermal Vacuum Valve	TVV
Throttle Position Sensor	TP Sensor
Throttle Position Switch	..
Transmission Range Switch	TR Switch
Vehicle Speed Sensor	VSS
Volume Air Flow Sensor	VAF

ACTUATOR ABBREVIATION TABLE

Actuator	Abbreviation
Air Injection Control Solenoid	..
Electronic Transmission control devices	..
Evaporative Emission Canister	EVAP
Purge Device	..
Exhaust Gas Recirculation Device	EGR
Fuel Injector	..
Idle Air Control	IAC

Idle Speed Control Actuator	ISC
Mix Control Solenoid	MC Solenoid
Secondary Air Injection System Management Device	AIR, PAIR
Vacuum Regulator Solenoid	..
Waste Gate Control Solenoid	..

SHROUDS, BAFFLES AND DEFLECTORS

SHROUD, BAFFLE AND DEFLECTOR INSPECTION

Condition	Code	Procedure
Application incorrect, affecting cooling system performance	A	Require repair or replacement.
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Bent, affecting cooling system performance	A	Require repair or replacement.
Blocked, affecting cooling system performance	A	Require repair or replacement.
Broken, affecting cooling system performance	A	Require repair or replacement.
Cracked, affecting cooling system performance	A	Require repair or replacement.
Loose, affecting cooling system performance	A	Require repair.
Loose, not affecting cooling system performance	2	Suggest repair.
Missing, affecting cooling system performance	C	Require replacement.

SPARK PLUGS

NOTE: You are not required to replace spark plugs in sets. However, you may suggest replacement of the other plugs for preventive maintenance.

SPARK PLUG INSPECTION

Condition	Code	Procedure
Application incorrect	B	Require replacement.
Electrode eroded	1	Suggest replacement.
Fouled	A	(1) Require repair or replacement.
Gap incorrect	B	Require repair or replacement.
Insulation broken	A	Require replacement
Insulator cracked	A	Require replacement.
Leaking compression	A	Require repair or replacement.
Maintenance interval	3	Suggest replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads		

missing)	A	Require replacement.

(1) - Determine cause of fouling and suggest repair.

SPRING LOCKS

SPRING LOCK INSPECTION

Condition	Code	Procedure
Leaking	A	(1) Require repair or replacement.

(1) - Require inspection of mating and sealing surface and repair or replace as necessary.

SUPER CHARGERS

SUPER CHARGER INSPECTION

Condition	Code	Procedure
Attaching hardware damaged, affecting operation or performance	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Bearing noisy	A	Require replacement.
Bearing worn	A	Require replacement.
Boost pressure incorrect	A	(1) Require repair or replacement.
Clearance out of specification	B	Require repair or replacement.
Leaking	A	Require repair or replacement.
Noisy	2	Suggest repair or replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require repair or replacement.

(1) - Boost pressure problems may be caused by other systems or components.

SWITCHES

SWITCH INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement

		of hardware.
Binding, affecting performance	A	Require repair or replacement.
Binding, not affecting performance	2	Suggest repair or replacement.
Broken	A	Require repair or replacement.
Burned, affecting performance	A	(1) Require repair or replacement.
Burned, not affecting performance	2	(1) Suggest repair or replacement.
Cracked, affecting performance	A	Require repair or replacement.
Cracked, not affecting performance	1	Suggest repair or replacement.
Leaking	A	Require repair or replacement.
Malfunctioning	A	(2) Require repair or replacement.
Melted, affecting performance	A	(1) Require repair or replacement.
Melted, not affecting performance	2	(1) Suggest repair or replacement.
Missing	C	Require replacement.
Out of adjustment	B	Require repair or replacement.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(1) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.
Won't return	A	Require repair or replacement.
Worn	1	Suggest replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - Includes inoperative, intermittent operation, or failure to perform all functions.

THERMAL VACUUM VALVES

THERMAL VACUUM VALVE INSPECTION

Condition	Code	Procedure
Connector broken	A	Require repair or replacement.
Connector (Weatherpack type) leaking	A	Require repair or replacement.
Connector melted	A	(1) Require repair or replacement.
Connector missing	C	Require replacement.
Contaminated	A	(2) Require repair or

		replacement.
Inoperative	B	.... (3) Require repair or replacement. Further inspection required.
Leaking	A	.. Require repair or replacement.
Missing	C	.... Require replacement.
Resistance out of specification	B	.. Require repair or replacement.
Restricted, affecting performance	A	.. Require repair or replacement.
Terminal broken	A	.. Require repair or replacement.
Terminal burned, affecting performance	A	.... (1) Require repair or replacement.
Terminal burned, not affecting performance ..	2	.. Suggest repair or replacement.
Terminal corroded, affecting performance ..	A	.. Require repair or replacement.
Terminal corroded, not affecting performance ..	2	.. Suggest repair or replacement.
Terminal loose, affecting performance	B	.. Require repair or replacement.
Terminal loose, not affecting performance ..	1	.. Suggest repair or replacement.
Threads damaged	A	.. Require repair or replacement.
Threads stripped (threads missing)	A	.... Require replacement.
Wire lead conductors exposed	B	.. Require repair or replacement.
Wire lead corroded	A	.. Require repair or replacement.
Wire lead open	A	.. Require repair or replacement.
Wire lead shorted	A	.. Require repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - Determine source of contamination, such as engine coolant, fuel, metal particles, or water. Require repair or replacement.
(3) - Inoperative includes intermittent operation or out of OEM specification. Some components may be serviceable; check for accepted cleaning procedure.

THERMOSTATIC AIR DOOR ASSEMBLIES

THERMOSTATIC AIR DOOR ASSEMBLY INSPECTION

Condition	Code	Procedure
Attaching hardware damaged, affecting operation or performance	A	... Require repair or replacement of hardware.
Attaching hardware missing	C	.... Require replacement of hardware.
Binding	A	.. Require repair or replacement.
Leaking	A	.. Require repair or replacement.
Missing	C	.... Require replacement.
Seized	A	.. Require repair or replacement.

THERMOSTATS AND HOUSINGS

THERMOSTAT AND HOUSING INSPECTION

Condition	Code	Procedure
Application incorrect	B	Require replacement.
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware corroded	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Housing corroded	1	Suggest replacement of housing.
Inoperative	A	(1) Require replacement.
Installation incorrect	B	Require repair or replacement.
Leaking	A	Require repair or replacement.
Thermostat missing	C	Require replacement of thermostat.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require repair or replacement.

(1) - Inoperative includes intermittent operation or out of OEM specification.

THROTTLE BODIES

THROTTLE BODY INSPECTION

Condition	Code	Procedure
Connector broken	A	Require repair or replacement.
Connector (Weatherpack type) leaking	A	Require repair or replacement.
Connector melted	A	(1) Require repair or replacement.
Connector missing	C	Require replacement.
Contaminated	A	(2) Require repair or replacement.
Leaking	A	Require repair or replacement.
Restricted	A	(3) Require repair.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(1) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.

Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require repair or replacement.
Throttle shaft binding, affecting performance	A	Require repair or replacement.
Throttle shaft worn, affecting performance	A	Require repair or replacement.
Throttle shaft worn, not affecting performance	1	Suggest repair or replacement.
Wire lead conductors exposed	B	Require repair or replacement.
Wire lead corroded	A	Require repair or replacement.
Wire lead open	A	Require repair or replacement.
Wire lead shorted	A	Require repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - Determine source of contamination, such as engine coolant, fuel, metal particles, or water. Require repair or replacement.
(3) - Some components may be serviceable; check for accepted cleaning procedure.

THROTTLE CABLES

See THROTTLE LINKAGES AND CABLES.

THROTTLE LINKAGES AND CABLES

THROTTLE LINKAGE AND CABLE INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Bent	A	Require repair or replacement.
Binding	A	Require repair or replacement.
Bracket bent, affecting performance	A	Require repair or replacement.
Bracket bent, not affecting performance	..	No service suggested or required.
Bracket broken, affecting performance	A	Require replacement.
Bracket broken, not affecting performance	..	No service suggested or required.
Bracket corroded, affecting performance	A	Require repair or replacement.
Bracket corroded, not affecting performance	2	Suggest repair or replacement.
Bracket cracked, affecting performance	A	Require repair or replacement.
Bracket cracked, not affecting performance	1	Suggest repair or replacement.

Bracket loose, affecting performance	A	Require repair or replacement.
Bracket loose, not affecting performance	1	Suggest repair or replacement.
Bracket missing	C	Require replacement.
Broken	A	Require replacement.
Cracked	A	Require repair or replacement.
Disconnected	A	Require repair or replacement.
Kinked	A	Require repair or replacement.
Melted	A	Require repair or replacement.
Missing	C	Require replacement.
Noisy	2	Suggest repair or replacement.
Out of adjustment	B	(1) Require repair or replacement.
Routed incorrectly	2	Suggest repair.
Seized	A	Require repair or replacement.

(1) - Follow OEM recommended adjustment procedures. Require repair or replacement if out of specification.

THROTTLE POSITION SENSORS

THROTTLE POSITION SENSOR INSPECTION

Condition	Code	Procedure
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware threads damaged	A	Require repair or replacement of hardware.
Attaching hardware threads stripped (threads missing)	A	Require repair or replacement of hardware.
Connector broken	A	Require repair or replacement.
Connector (Weatherpack type) leaking	A	Require repair or replacement.
Connector melted	A	(1) Require repair or replacement.
Connector missing	C	Require replacement.
Contaminated	A	(2) Require repair or replacement.
Inoperative	B	(3) Require repair or replacement. Further inspection required.
Missing	C	Require replacement.
Resistance out of specification	B	Require repair or replacement.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(1) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not		

affecting performance ..	1	.. Suggest repair or replacement.
Threads damaged	A	.. Require repair or replacement.
Threads stripped (threads missing)	A	.... Require replacement.
Wire lead conductors exposed	B	.. Require repair or replacement.
Wire lead corroded	A	.. Require repair or replacement.
Wire lead open	A	.. Require repair or replacement.
Wire lead shorted	A	.. Require repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - Determine source of contamination, such as engine coolant, fuel, metal particles, or water. Require repair or replacement.
(3) - Inoperative includes intermittent operation or out of OEM specification. Some components may be serviceable; check for accepted cleaning procedure.

THROTTLE POSITION SWITCHES

THROTTLE POSITION SWITCH INSPECTION

Condition	Code	Procedure
Attaching hardware missing	C	.... Require replacement of hardware.
Attaching hardware threads damaged	A	... Require repair or replacement of hardware.
Attaching hardware threads stripped (threads missing)	A	.. Require repair or replacement of hardware.
Connector broken	A	.. Require repair or replacement.
Connector (Weatherpack type) leaking	A	.. Require repair or replacement.
Connector melted	A	.... (1) Require repair or replacement.
Connector missing	C	.... Require replacement.
Inoperative	B	.... (2) Require repair or replacement. Further inspection required.
Missing	C	.... Require replacement.
Resistance out of specification	B	.. Require repair or replacement.
Terminal broken	A	.. Require repair or replacement.
Terminal burned, affecting performance	A	.... (1) Require repair or replacement.
Terminal burned, not affecting performance ..	2	.. Suggest repair or replacement.
Terminal corroded, affecting performance ..	A	.. Require repair or replacement.
Terminal corroded, not affecting performance ..	2	.. Suggest repair or replacement.
Terminal loose, affecting performance	B	.. Require repair or replacement.
Terminal loose, not affecting performance ..	1	.. Suggest repair or replacement.
Threads damaged	A	.. Require repair or replacement.

Threads stripped (threads missing)	A	Require replacement.
Wire lead conductors exposed	B	Require repair or replacement.
Wire lead corroded	A	Require repair or replacement.
Wire lead open	A	Require repair or replacement.
Wire lead shorted	A	Require repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - Inoperative includes intermittent operation or out of OEM specification. Some components may be serviceable; check for accepted cleaning procedure.

TIMING BELT SPROCKETS

TIMING BELT SPROCKET INSPECTION

Condition	Code	Procedure
Alignment incorrect	B	Require repair.
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Bent	A	Require replacement.
Cracked	A	Require replacement.
Key damaged	A	Require replacement.
Loose	A	Require repair or replacement.
Missing	C	Require replacement.
Pulley damaged, affecting belt life	A	Require replacement.
Sprocket damaged, affecting belt life	A	Require repair or replacement.
Sprocket loose	B	Require repair or replacement.
Sprocket-to-shaft alignment incorrect	B	Require repair or replacement.

TIMING BELTS

TIMING BELT INSPECTION

Condition	Code	Procedure
Adjustment incorrect	2	(1) Suggest adjustment.
Alignment incorrect	B	(2) Further inspection required.
Broken	A	Require replacement.
Cam timing out of specification	B	Require repair.
Cracked	1	Suggest replacement.
Fluid-soaked	1	Suggest replacement. Further inspection required.
Frayed	1	Suggest replacement.
Maintenance intervals	3	Suggest replacement to comply with vehicle OEM recommended

		service intervals.
Missing	C	(3) Require replacement.
Noisy	2	(4) Further inspection required. See note below.
Plies separated	A	Require replacement.
Tension out of specification	B	Require adjustment or replacement.
Teeth missing	A	Require replacement.

(1) - Inspect belt tensioners, pulleys, and cover.
(2) - Determine cause of incorrect alignment and require repair.
(3) - CAUTION: Internal engine damage may result from timing belt damage/failure.
(4) - Determine cause of noise and suggest repair.

TORQUE STRUTS

TORQUE STRUT INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Binding	A	Require replacement.
Body dented	A	(1) Further inspection required.
Body punctured	A	Require replacement.
Bushing deteriorated, affecting performance	A	Require replacement.
Bushing deteriorated, not affecting performance	..	No service suggested or required.
Bushings missing	C	Require replacement.
Bushings separated from mounting eye	1	Suggest replacement.
Damping (none)	A	Require replacement.
Leaking oil, enough for fluid to be running down the body	A	Require replacement.
Missing	C	Require replacement.
Noisy	2	(2) Further inspection required.
Piston rod bent	A	Require replacement.
Piston rod broken	A	Require replacement.
Seized	A	Require replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.

(1) - Require replacement of units where dents restrict strut piston rod movement. If dents don't restrict movement, no service is suggested or required.
(2) - If noise is isolated to shock or strut, suggest replacement.

TRANSMISSION RANGE SWITCHES

TRANSMISSION RANGE SWITCH INSPECTION

Condition	Code	Procedure
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware threads damaged	A	Require repair or replacement of hardware.
Attaching hardware threads stripped (threads missing)	A	Require repair or replacement of hardware.
Connector broken	A	Require repair or replacement.
Connector (Weatherpack type) leaking	A	Require repair or replacement.
Connector melted	A	(1) Require repair or replacement.
Connector missing	C	Require replacement.
Contaminated	A	(2) Require repair or replacement.
Inoperative	B	(3) Require repair or replacement. Further inspection required.
Leaking	A	Require repair or replacement.
Missing	C	Require replacement.
Resistance out of specification	B	Require repair or replacement.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(1) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.
Wire lead conductors exposed	B	Require repair or replacement.
Wire lead corroded	A	Require repair or replacement.
Wire lead open	A	Require repair or replacement.
Wire lead shorted	A	Require repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - Determine source of contamination, such as engine coolant, fuel, metal particles, or water. Require repair or replacement.
(3) - Inoperative includes intermittent operation or out of OEM specification. Some components may be serviceable;

check for accepted cleaning procedure.

TUBE CLAMPS

See HOSE AND TUBE COUPLERS, CONNECTORS AND CLAMPS.

TUBE CONNECTORS

See HOSE AND TUBE COUPLERS, CONNECTORS AND CLAMPS.

TUBE COUPLERS

See HOSE AND TUBE COUPLERS, CONNECTORS AND CLAMPS.

TUBES

See HOSES AND TUBES (FUEL LINES, RADIATOR, BY PASS, HEATER, RECOVERY TANK AND OIL COOLERS).

TURBO CHARGERS

TURBO CHARGER INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Boost pressure incorrect	A	(1) Require repair or replacement.
Leaking	A	Require repair or replacement.
Noisy	2	Suggest repair or replacement.
Oil seal (internal) leaking	A	Require repair or replacement.
Vibrates	A	Require repair or replacement.

(1) - Boost pressure problems may be caused by other systems or components.

VACUUM CONNECTIONS

See VACUUM HOSES, TUBES AND CONNECTIONS (NON-METALLIC).

VACUUM HOSES, TUBES AND CONNECTIONS (NON-METALLIC)

VACUUM HOSE, TUBE AND CONNECTION (NON-METALLIC) INSPECTION

Condition	Code	Procedure
Leaking	A	Require repair or replacement.
Melted	A	Require replacement.
Missing	C	Require replacement.
Oil-soaked (spongy)	1	Suggest replacement.

Restricted	A	Require repair or replacement.
Surface cracks (dry-rotted)	1	Suggest replacement.

VACUUM REGULATOR SOLENOIDS

VACUUM REGULATOR SOLENOID INSPECTION

Condition	Code	Procedure
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware threads damaged	A	Require repair or replacement of hardware.
Attaching hardware threads stripped (threads missing)	A	Require repair or replacement of hardware.
Connector broken	A	Require repair or replacement.
Connector (Weatherpack type) leaking	A	Require repair or replacement.
Connector melted	A	(1) Require repair or replacement.
Connector missing	C	Require replacement.
Contaminated	A	(2) Require repair or replacement.
Inoperative	B	(3) Require repair or replacement. Further inspection required.
Leaking	A	Require repair or replacement.
Missing	C	Require replacement.
Resistance out of specification	B	Require repair or replacement.
Restricted, affecting performance	A	Require repair or replacement.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(1) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.
Wire lead conductors exposed	B	Require repair or replacement.
Wire lead corroded	A	Require repair or replacement.
Wire lead open	A	Require repair or replacement.
Wire lead shorted	A	Require repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.

(2) - Determine source of contamination, such as engine coolant, fuel, metal particles, or water. Require repair or replacement.
(3) - Inoperative includes intermittent operation or out of OEM specification. Some components may be serviceable; check for accepted cleaning procedure.

VACUUM TUBES

See VACUUM HOSES, TUBES AND CONNECTIONS (NON-METALLIC).

VEHICLE SPEED SENSORS

VEHICLE SPEED SENSOR INSPECTION

Condition	Code	Procedure
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware threads damaged	A	Require repair or replacement of hardware.
Attaching hardware threads stripped (threads missing)	A	Require repair or replacement of hardware.
Connector broken	A	Require repair or replacement.
Connector (Weatherpack type) leaking	A	Require repair or replacement.
Connector melted	A	(1) Require repair or replacement.
Connector missing	C	Require replacement.
Contaminated	A	(2) Require repair or replacement.
Inoperative	B	(3) Require repair or replacement. Further inspection required.
Leaking	A	Require repair or replacement.
Missing	C	Require replacement.
Resistance out of specification	B	Require repair or replacement.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(1) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.
Wire lead conductors exposed	B	Require repair or replacement.
Wire lead corroded	A	Require repair or replacement.

Wire lead open	A	Require repair or replacement.
Wire lead shorted	A	Require repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - Determine source of contamination, such as engine coolant, fuel, metal particles, or water. Require repair or replacement.
(3) - Inoperative includes intermittent operation or out of OEM specification. Some components may be serviceable; check for accepted cleaning procedure.

VOLUME AIR FLOW SENSORS

VOLUME AIR FLOW SENSOR INSPECTION

Condition	Code	Procedure
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware threads damaged	A	Require repair or replacement of hardware.
Attaching hardware threads stripped (threads missing)	A	Require repair or replacement of hardware.
Connector broken	A	Require repair or replacement.
Connector (Weatherpack type) leaking	A	Require repair or replacement.
Connector melted	A	(1) Require repair or replacement.
Connector missing	C	Require replacement.
Contaminated	A	(2) Require repair or replacement.
Inoperative	B	(3) Require repair or replacement. Further inspection required.
Leaking	A	Require repair or replacement.
Missing	C	Require replacement.
Resistance out of specification	B	Require repair or replacement.
Restricted, affecting performance	A	Require repair or replacement.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(1) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.

Wire lead conductors exposed	B	Require repair or replacement.
Wire lead corroded	A	Require repair or replacement.
Wire lead open	A	Require repair or replacement.
Wire lead shorted	A	Require repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - Determine source of contamination, such as engine coolant, fuel, metal particles, or water. Require repair or replacement.
(3) - Inoperative includes intermittent operation or out of OEM specification. Some components may be serviceable; check for accepted cleaning procedure.

WASTE GATE CONTROL SOLENOIDS

WASTE GATE CONTROL SOLENOID INSPECTION

Condition	Code	Procedure
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware threads damaged	A	Require repair or replacement of hardware.
Attaching hardware threads stripped (threads missing)	A	Require repair or replacement of hardware.
Connector broken	A	Require repair or replacement.
Connector (Weatherpack type) leaking	A	Require repair or replacement.
Connector melted	A	(1) Require repair or replacement.
Connector missing	C	Require replacement.
Contaminated	A	(2) Require repair or replacement.
Inoperative	B	(3) Require repair or replacement. Further inspection required.
Leaking	A	Require repair or replacement.
Missing	C	Require replacement.
Resistance out of specification	B	Require repair or replacement.
Restricted, affecting performance	A	Require repair or replacement.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(1) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.

Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.
Wire lead conductors exposed	B	Require repair or replacement.
Wire lead corroded	A	Require repair or replacement.
Wire lead open	A	Require repair or replacement.
Wire lead shorted	A	Require repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - Determine source of contamination, such as engine coolant, fuel, metal particles, or water. Require repair or replacement.
(3) - Inoperative includes intermittent operation or out of OEM specification. Some components may be serviceable; check for accepted cleaning procedure.

WASTE GATES AND BOOST CONTROL MECHANISMS

WASTE GATE AND BOOST CONTROL MECHANISM INSPECTION

Condition	Code	Procedure
Boost pressure incorrect	A	(1) Require repair or replacement. Further inspection required.
Leaking	A	Require repair or replacement.

(1) - Incorrect boost pressure includes intermittent operation or out of OEM specification.

WATER PUMPS (ELECTRIC)

WATER PUMP (ELECTRIC) INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Connector broken	A	Require repair or replacement.
Connector (Weatherpack type) leaking	A	Require repair or replacement.
Connector melted	A	(1) Require repair or replacement.
Connector missing	C	Require replacement.
Inoperative	A	(2) Require replacement.
Leaking	A	Require repair or replacement.
Missing	C	Require replacement.
Noisy	2	Suggest replacement.
Rotation incorrect for application	B	Require repair or replacement.
Terminal broken	A	Require repair or replacement.

Terminal burned, affecting performance	A	(1) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.
Vibration	1	Suggest replacement.
Wire lead conductors exposed	B	Require repair or replacement.
Wire lead corroded	A	Require repair or replacement.
Wire lead open	A	Require repair or replacement.
Wire lead shorted	A	Require repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.
(2) - Check fan motor/controls. Inoperative includes intermittent operation or out of OEM specification.

WATER PUMPS (NON-ELECTRIC)

WATER PUMP (NON-ELECTRIC) INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware corroded	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Corrosion (internal) is excessive, affecting performance	A	Require replacement.
Corrosion (internal) is excessive, not affecting performance	2	Suggest cooling system service.
Inoperative	A	(1) Require replacement.
Leaking	A	Require replacement.
Noisy	A	Require replacement.
Rotation incorrect for application	B	Require repair or replacement.
Shaft bent	A	Require replacement.

(1) - Inoperative includes intermittent operation or out of OEM specification.

WIRING HARNESSES AND CONNECTORS

WIRING HARNESS AND CONNECTOR INSPECTION

Condition	Code	Procedure
Application incorrect	B	Require repair or replacement.
Attaching hardware broken	A	Require repair or replacement of hardware.
Attaching hardware missing	C	Require replacement of hardware.
Attaching hardware not functioning	A	Require repair or replacement of hardware.
Connector broken	A	Require repair or replacement.
Connector (Weatherpack type) leaking	A	Require repair or replacement.
Connector melted	A	(1) Require repair or replacement.
Connector missing	C	Require replacement.
Insulation damaged, conductors exposed	A	Require repair or replacement.
Insulation damaged, conductors not exposed	1	Suggest replacement.
Open	A	Require repair or replacement.
Protective shield (conduit) melted	2	(1) Suggest repair or replacement.
Protective shield (conduit) missing	2	Suggest repair or replacement.
Resistance (voltage drop) out of specification	A	Require repair or replacement.
Routed incorrectly	B	Require repair.
Secured incorrectly	B	Require repair.
Shorted	A	Require repair or replacement.
Terminal broken	A	Require repair or replacement.
Terminal burned, affecting performance	A	(1) Require repair or replacement.
Terminal burned, not affecting performance	2	Suggest repair or replacement.
Terminal corroded, affecting performance	A	Require repair or replacement.
Terminal corroded, not affecting performance	2	Suggest repair or replacement.
Terminal loose, affecting performance	B	Require repair or replacement.
Terminal loose, not affecting performance	1	Suggest repair or replacement.
Voltage drop out of specification	A	Require repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.

A - ENGINE/VIN ID

1988 Jeep Cherokee

1984-89 ENGINE PERFORMANCE
Chrysler Motors/Jeep VIN Code Identification

Jeep; Cherokee, Wagoneer

MODEL IDENTIFICATION

VIN CODE LOCATION

The Vehicle identification number (VIN) is located on the left side of the dash panel at the base of the windshield.

VIN CODE ID EXPLANATION

Numbers preceding the explanations in the legend below refer to the sequence of characters as listed on VIN identification label. See VIN example below.

(VIN)	1	J	C	U	N	7	7	1	X	G	T	0	0	0	0	0	1
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17

1 - Manufacturing Country
  1 * United States

2 - Company/Make
  J * Chrysler Motors/Jeep

3 - Type (1984-88)
  C * Multi-Purpose Vehicle
  D * Incomplete Vehicle

3 - Type (1989)
  3 * Multi-Purpose Vehicle
  6 * Incomplete Vehicle
  7 * Truck

4 - Engine Type (1984-88)
  B * 2.1L (128 Cu. In.) 4-Cylinder Turbo (Diesel)
  H * 2.5L (150 Cu. In.) 4-Cylinder TBI (Gasoline)
  U * 2.5L (150 Cu. In.) 4-Cylinder 1 Bbl. (Gasoline)
  W * 2.8L (171 Cu. In.) V6 2 Bbl. (Gasoline)
  M * 4.0L (242 Cu. In.) 6-Cylinder (Gasoline)

4 - GVWR (1989)
  E * 3001-4000
  F * 4001-5000
  G * 5001-6000
  H * 6001-7000

5 - Transmission/(Transfer Case) (1984-88)
  L * 5-Speed Manual Floor Shift (Part Time 4WD)
  X * 4-Speed Manual Floor Shift (Part Time 4WD)
  B * Auto Floor Shift (Part Time 4WD)
  C * Auto Floor Shift (Full Time 4WD)
  E * Auto Column Shift (Part Time 4WD)
  J * Auto Column Shift (Full Time 4WD)
  A * Auto Column Shift (2WD)

S * 4-Speed Manual Floor Shift (2WD)
D * Auto Floor Shift (2WD)
W * 5-Speed Manual Shift (2WD)

5 - Car Line (1989)
J * Cherokee 4WD
N * Wagoneer 4WD
T * Cherokee 2WD

6 - Body Style (4WD) (1984-88)
75 * Wagoneer Wagon 4-Door
77 * Cherokee Wagon 2-Door
78 * Cherokee Wagon 4-Door

6 - Series (1989)
2 * Base (L)
3 * Pioneer (M)
5 * Laredo (P)
7 * Limited (X)

7 - Body Style (2WD) (1984-1988)
73 * Cherokee Wagon 2-Door
74 * Cherokee Wagon 4-Door

7 - Body Style (1989)
5 * 4-Door Wagon
7 * 2-Door Wagon
8 * 4-Door Wagon

8 - Trim Package (1984-88)
1 * Custom
2 * Pioneer
3 * Chief
4 * Laredo
5 * Wagoneer
6 * Limited
K * Cherokee Base (2WD)
L * Pioneer (2WD)
M * Laredo (2WD)

8 - Engine (1989)
E * 2.5L
L * 4.0L
P * 2.5L
S * 4.0L

9 - Check Digit
* Manufacturer Assigned

10 - Model Year
E * 1984
F * 1985
G * 1986
H * 1987
J * 1988
K * 1989

11 - Assembly Plant
J * Brampton, Ontario, Canada
L * Toledo, Ohio Plant No. 1
P * Toledo, Ohio Plant No. 2
T * Toledo, Ohio

12-17 - Sequential Serial Number
    * Production Sequence

* EXHAUST SYSTEM UNIFORM INSPECTION GUIDELINES *

1988 Jeep Cherokee

GENERAL INFORMATION
Exhaust Systems Motorist Assurance Program
Standards For Automotive Repair

All Makes and Models

INTRODUCTION TO MOTORIST ASSURANCE PROGRAM (MAP)

CONTENTS

INTRODUCTION TO MOTORIST ASSURANCE PROGRAM (MAP)

OVERVIEW OF MOTORIST ASSURANCE PROGRAM

The Motorist Assurance Program is the consumer outreach effort of the Automotive Maintenance and Repair Association, Inc. (AMRA). Participation in the Motorist Assurance Program is drawn from retailers, suppliers, independent repair facilities, vehicle manufacturers and industry associations.

Our organization's mission is to strengthen the relationship between the consumer and the auto repair industry. We produce materials that give motorists the information and encouragement to take greater responsibility for their vehicles-through proper, manufacturer-recommended, maintenance. We encourage participating service and repair shops (including franchisees and dealers) to adopt (1) a Pledge of Assurance to their Customers and (2) the Motorist Assurance Program Standards of Service. All participating service providers have agreed to subscribe to this Pledge and to adhere to the promulgated Standards of Service demonstrating to their customers that they are serious about customer satisfaction.

These Standards of Service require that an inspection of the vehicle's (problem) system be made and the results communicated to the customer according to industry standards. Given that the industry did not have such standards, the Motorist Assurance Program successfully promulgated industry inspection communication standards in 1994-95 for the following systems: Exhaust, Brakes, ABS, Steering and Suspension, Engine Maintenance and Performance, HVAC, and Electrical Systems. Further, revisions to all of these inspection communication standards are continually re-published. In addition to these, standards for Drive Train and Transmissions have recently been promulgated. Participating shops utilize these Uniform Inspection & Communication

Standards as part of the inspection process and for communicating their findings to their customers.

The Motorist Assurance Program continues to work cooperatively and proactively with government agencies and consumer groups toward solutions that both benefit the customer and are mutually acceptable to both regulators and industry. We maintain the belief that industry must retain control over how we conduct our business, and we must be viewed as part of the solution and not part of the problem. Meetings with state and other government officials (and their representatives), concerned with auto repair and/or consumer protection, are conducted. Feedback from these sessions is brought back to the association, and the program adjusted as needed.

To assure auto repair customers recourse if they were not satisfied with a repair transaction, the Motorist Assurance Program offers mediation and arbitration through MAP/BBB-CARE and other non-profit organizations. MAP conducted pilot programs in twelve states before announcing the program nationally in October, 1998. During the pilots, participating repair shops demonstrated their adherence to the Pledge and Standards and agreed to follow the UICS in communicating the results of their inspection to their customers. To put some "teeth" in the program, an accreditation requirement for shops was initiated. The requirements are stringent, and a self-policing method has been incorporated which includes the "mystery shopping" of outlets.

We welcome you to join us as we continue our outreach... with your support, both the automotive repair industry and your customers will reap the benefits. Please visit MAP at our Internet site www. motorist.org or contact us at:

1444 I Street, NW Suite 700
Washington, DC 20005
Phone (202) 712-9042 Fax (202) 216-9646
January 1999

MAP UNIFORM INSPECTION GENERAL GUIDELINES

OVERVIEW OF SERVICE REQUIREMENTS AND SUGGESTIONS

It is MAP policy that all exhaust, brake, steering, suspension, wheel alignment, drive-line, engine performance and maintenance, and heating, ventilation and air conditioning, and electrical services be offered and performed under the standards and procedures specified in these sections.

Before any service is performed on a vehicle, an inspection of the appropriate system must be performed. The results of this inspection must be explained to the customer and documented on an inspection form. The condition of the vehicle and its components will indicate what services/part replacements may be "Required" or "Suggested". In addition, suggestions may be made to satisfy the requests expressed by the customer.

When a component is suggested or required to be repaired or replaced, the decision to repair or replace must be made in the customer’s best interest, and at his or her choice given the options available.

This section lists the various parts and conditions that indicate a required or suggested service or part replacement. Although this list is extensive, it is not fully inclusive. In addition to this list, a technician may make a suggestion. However, any suggestions must be based on substantial and informed experience, or the vehicle manufacturer’s recommended service interval and must be documented.

Some conditions indicate that service or part replacement is

required because the part in question is no longer providing the function for which it is intended, does not meet a vehicle manufacturer's design specification or is missing.

Example:
An exhaust pipe has corroded severely and has a hole in it through which exhaust gases are leaking. Replacement of the exhaust pipe in this case is required due to functional failure.

Example:
A brake rotor has been worn to the point where it measures less than the vehicle manufacturer's discard specifications. Replacement of the rotor is required because it does not meet design specifications.

Some conditions indicate that a service or part replacement is suggested because the part is close to the end of its useful life or addresses a customer's need, convenience or request. If a customer's vehicle has one of these conditions, the procedure may be only to suggest service.

Example:
An exhaust pipe is rusted, corroded or weak, but no leaks are present. In this case, the exhaust pipe has not failed. However, there is evidence that the pipe may need replacement in the near future. Replacement of the pipe may be suggested for the customer's convenience in avoiding a future problem.

Example:
The customer desires improved ride and/or handling, but the vehicle's shocks or struts have not failed. In this case, replacement may be suggested to satisfy the customer's wishes. In this case, replacement of the shocks or struts may not be sold as a requirement.

A customer, of course, has the choice of whether or not a shop will service his or her vehicle. He or she may decide not to follow some of your suggestions. When a repair is required, a MAP shop must refuse partial service on that system if, in the judgment of the service provider, proceeding with the work could create or continue an unsafe condition. When a procedure states that required or suggested repair or replacement is recommended, the customer must be informed of the generally acceptable repair/replacement options whether or not performed by the shop.

When presenting suggested repairs to the customer, you must present the facts, allowing the customer to draw their own conclusions and make an informed decision about how to proceed.

The following reasons may be used for required and suggested services. These codes are shown in the "Code" column of the MAP Uniform Inspection & Communications Standards that follow:

Reasons to Require Repair or Replacement
A – Part no longer performs intended purpose
B – Part does not meet a design specification (regardless of performance)
C – Part is missing

NOTE: When a repair is required, the shop must refuse partial service to the system in question, if the repair creates or continues an unsafe condition.

Reasons to Suggest Repair or Replacement

1 - Part is close to the end of its useful life (just above discard specifications, or weak; failure likely to occur soon, etc.)
2 - To address a customer need, convenience, or request (to stiffen ride, enhance performance, eliminate noise, etc.)
3 - To comply with maintenance recommended by the vehicle's Original Equipment Manufacturer (OEM)
4 - Technician's recommendation based on substantial and informed experience

NOTE: Suggested services are always optional. When presenting suggested repairs to the customer, you must present the facts, allowing the customer to draw their own conclusions and make an informed decision about how to proceed.

EXHAUST

SERVICE PROCEDURES REQUIRED AND SUGGESTED FOR PROPER VEHICLE OPERATION

WARNING: Federal EPA rules prohibit altering an exhaust system in any way that defeats the emission reduction components of a vehicle. Be sure to review and adhere to EPA policy on removing and replacing catalytic converters. Where state or local laws are stricter, they take precedence over these guidelines.

NOTE: Some exhaust systems are of a welded design. It is not required that the entire system be replaced. Determine the need to replace individual components based on conditions of component.

CATALYTIC CONVERTERS

CAUTION: Before working on an exhaust system, review EPA regulations on removing and replacing catalytic converters.

NOTE: Any time a converter has failed, further diagnosis is required to determine the reason(s) for converter failure.

CATALYTIC CONVERTER INSPECTION

Condition	Code	Procedure
Air injection tube broken	A	Require repair or replacement of injection tube or replacement of catalytic converter.
Air injection tube burnt	A	Require repair or replacement of injection tube or replacement of catalytic converter.
Air injection tube leaking	A	Require repair or replacement of injection tube or replacement of catalytic converter.
Air injection tube		

loose	A	Require repair or replacement of injection tube or replacement of catalytic converter.
Air injection tube restricted	A	Require repair or replacement of injection tube or replacement of catalytic converter.
Air injection tube threads damaged	A	Require repair or replacement of injection tube or replacement of catalytic converter.
Air injection tube threads stripped (threads missing)	A	Require repair or replacement of injection tube or replacement of catalytic converter.
Body cracked	B	Require repair or replacement.
Converter empty	A	Require repair or replacement.
Converter fill plug missing	C	Require repair or replacement.
Converter missing	C	Require replacement.
Exhaust gases leaking	A	Require repair or replacement.
Flanges leaking	A	Require repair or replacement of flanges.
Inlet pipes cracked	B	Require repair or replacement.
Internal rattle (except pellet-type)	2	(1) Further inspection required.
Mounting brackets that are part of converter broken	A	Require repair or replacement.
Obvious overheating	..	(2) Require testing of converter.
Outlet pipes cracked	B	Require repair or replacement.
Pieces of catalyst material found downstream	1	Suggest replacement.
Plugged	A	(3) Require replacement.
Testing has determined that existing converter has been lead-poisoned, contaminated, or failed testing	A	Require repair or replacement.

(1) - If the converter is breaking up, suggest converter replacement. If an object has fallen into the converter, remove the object.
(2) - Overheating is caused by something other than the converter. Further diagnosis is required to determine the cause of the overheating.
(3) - Determine cause and correct to ensure that new converter will not become plugged.

EXHAUST AND TAIL PIPES

NOTE: For pipes with resonators, also see MUFFLERS AND RESONATORS.

EXHAUST AND TAIL PIPE INSPECTION

Condition	Code	Procedure
Bracket broken	A	.. Require repair or replacement.
Pipe bent out of position	B	.. Require repair or replacement.
Pipe broken	A	.. Require repair or replacement.
Pipe cracked	B	.. Require repair or replacement.
Pipe leaking	A	.... Require replacement.
Pipe missing	C	.... Require replacement.
Pipe plugged	A	.... Require replacement.
Pipe weak due to corrosion, but no leaks present	1	.... Suggest replacement.
Weld broken	A	.. Require repair or replacement.

EXHAUST CONNECTIONS

EXHAUST CONNECTION INSPECTION

Condition	Code	Procedure
Attaching hardware incorrect	B	.... Require replacement of hardware.
Clamp broken	A	.... Require replacement.
Clamp loose	A	. Require repair or replacement.
Clamp missing	C	.... Require replacement.
Corroded, affecting structural integrity ...	1	.... Suggest replacement.
Incorrect type (i.e. flange, ball & socket etc.)	B	.... Require replacement.
Leaking	A	.... Require repair.
Loose	A	.... Require repair.

HANGERS

HANGER INSPECTION

Condition	Code	Procedure
Broken	A	.... Require replacement.
Corroded, affecting structural integrity ...	1	.... Suggest replacement.
Incorrect type	B	.... Require replacement.
Loose	A	.. Require repair or replacement.
Missing	C	.... Require replacement.
Out of position	B	.. Require repair or replacement.
Rubber deteriorated	1	.... Suggest replacement.

HEAT RISERS (MECHANICAL EFE DEVICES)

HEAT RISER (MECHANICAL EFE DEVICE) INSPECTION

Condition	Code	Procedure
Broken	A	.... Require replacement of affected parts.
Diaphragm inoperative ...	A	.... (1) Require replacement.

Leaking	A	Require repair or replacement.
Noisy	2	Suggest repair or replacement of affected parts.
Seized	A	Require repair or replacement of affected parts.
Spring broken	B	Require replacement of spring(s).
Spring inoperative	A	Require replacement of spring(s).

(1) - If the inoperative diaphragm is separate from the heat riser, then require replacement of the inoperative diaphragm. If the inoperative diaphragm is part of the heat riser, then replace the heat riser.

HEAT SHIELDS

HEAT SHIELD INSPECTION

Condition	Code	Procedure
Bent	B	Require repair or replacement.
Broken	A	Require replacement.
Corroded, affecting structural integrity	1	Suggest replacement.
Loose	A	Require repair or replacement.
Missing	C	Require replacement.

MANIFOLDS (CAST AND TUBE TYPE)

MANIFOLD (CAST AND TUBE TYPE) INSPECTION

Condition	Code	Procedure
Air injection tube in manifold broken	A	Require repair or replacement of injection tube or replacement of manifold.
Air injection tube in manifold corroded, affecting structural integrity	1	Suggest replacement of injection tube or manifold.
Air injection tube in manifold leaking	A	Require repair or replacement of injection tube or replacement of manifold.
Air injection tube in manifold loose	A	Require repair.
Air injection tube in manifold restricted	A	Require replacement of injection tube or manifold.
Air injection tube in manifold threads damaged	A	Require repair of injection tube or manifold.
Air injection tube in manifold threads stripped (threads missing)	A	Require replacement of injection tube or manifold.
Bolt broken	A	Require replacement of bolts.

Bolt loose	A	Require tightening or replacement of bolts.
Bolt missing	C	Require replacement of bolts.
Corroded, affecting sealability	A	Require repair or replacement.
Cylinder head threads stripped	A	Require repair or replacement of cylinder head.
Gasket leaking	A	Require tightening or replacement of gasket.
Heat stove bent	B	(1) Require repair or replacement of stove.
Heat stove broken	A	(1) Require replacement of stove.
Heat stove corroded, affecting structural integrity	1	(1) Suggest replacement of stove.
Heat stove missing	C	(1) Require replacement of stove.
Manifold broken	A	Require repair or replacement.
Manifold cracked	B	Require repair or replacement.
Manifold warped	A	Require repair or replacement.
Out of specification	B	Require repair or replacement.
Stud broken	A	Require replacement of stud.
Stud missing	C	Require replacement of stud.
Stud threads damaged	A	Require repair or replacement of stud.
Stud threads stripped (threads missing)	A	Require replacement of stud.

(1) - Stove may not be available separately; this may require replacement of manifold.

MECHANICAL EFE DEVICES

See HEAT RISERS (MECHANICAL EFE DEVICES).

MUFFLERS AND RESONATORS

MUFFLER AND RESONATOR INSPECTION

Condition	Code	Procedure
Body shell distorted, affecting performance or structural integrity	A	Require replacement.
Corrosion hole	A	Require replacement.
Missing	C	Require replacement.
Mounting bracket broken	A	Require repair or replacement.
Mounting bracket cracked	B	Require repair or replacement.
Nipple cracked	A	Require repair or replacement.
Nipple loose	B	Require replacement.
Outer wrap peeling (exhaust not leaking)	1	Suggest replacement.
Plugged	A	Require replacement.
Puncture (other than a drain hole)	A	Require replacement.
Rattling or knocking noise from inside muffler	B	Require replacement.
Seam open (exhaust		

leaking)	A	.... Require replacement.
Sound quality unsatisfactory	2	.. Suggest replacement to address customer need and/or request.
Split (exhaust leaking) .	A	.... Require replacement.
Weak due to corrosion, but no leaks present	1	.... Suggest replacement.

FUEL EVAPORATION SYSTEM

1988 Jeep Cherokee

1988 Exhaust Emission Systems
FUEL EVAPORATION SYSTEMS

JEEP

DESCRIPTION

The Evaporative Emission Control System (EECS), prevents raw fuel vapors from entering the atmosphere. It consists of a venting system which allows only vaporous fuel to be drawn into the system.

During engine operation, vapors are drawn through system vent lines and into intake manifold. When engine is off, fuel vapors are stored in vapor storage canister charcoal. Vapors are drawn into intake manifold when engine is running again. See Fig. 1.

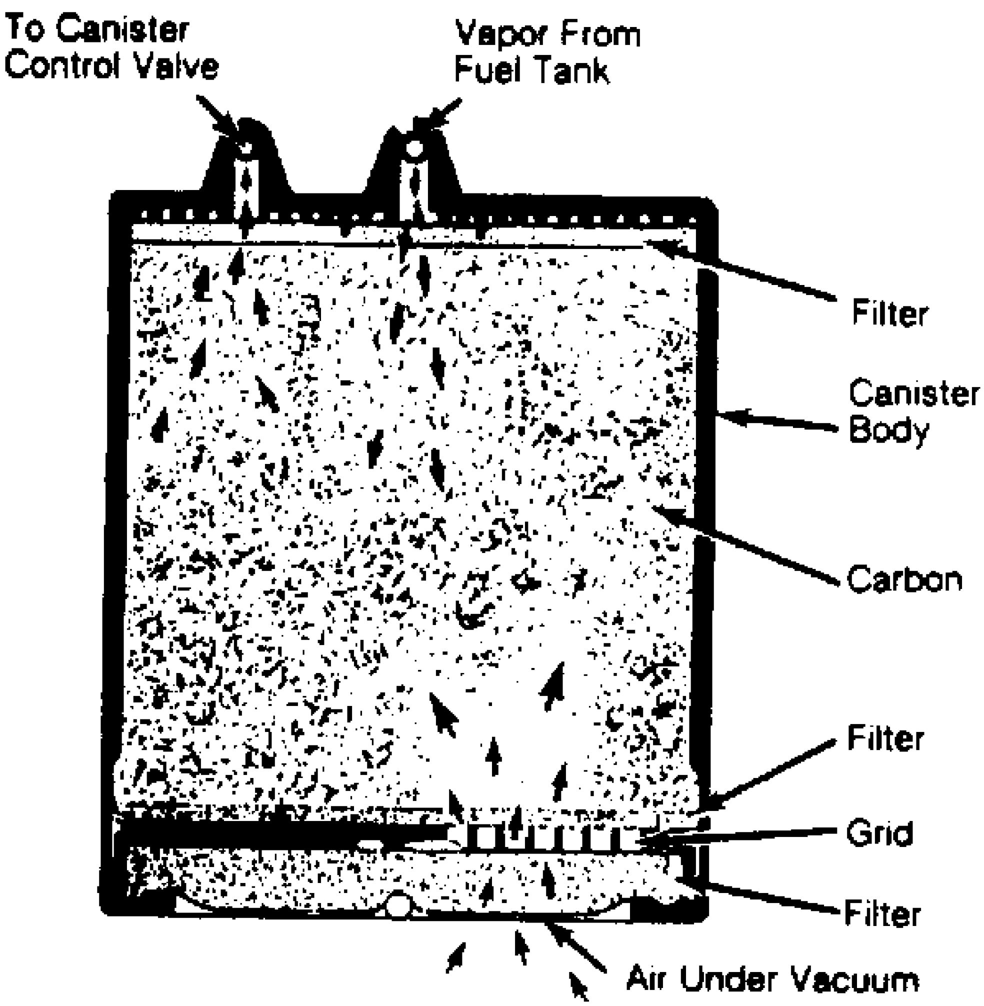


Fig. 1: Open-Bottom Canister (2-Tube Type)
Courtesy of General Motors Corp.

OPERATION

Roll-Over Check Valve

When valve is inverted, a stainless steel ball pushes a plunger against its seat, blocking fuel flow through valve.

Charcoal Canister

All models are equipped with a dual-purge type canister. An inlet is provided for carburetor fuel bowl vapors and another one for fuel tank vapors. The outlet is connected to intake manifold vacuum. A secondary purge fourth nipple connects to carburetor ported vacuum.

During engine operation, manifold vacuum draws fresh air through inlet filter in bottom of canister and purges stored vapors. When ported vacuum reaches 12 in. Hg, secondary purge circuit is opened and canister purges at a much higher rate.

Carburetor Bowl Vent

The carburetor bowl vent provides an outlet for fuel vapors when engine is not operating. During engine operation, fuel bowl is vented to inside of air cleaner. The bowl is automatically closed by mechanical link to throttle when engine is started.

MAINTENANCE

No adjustments are required with this system. Replace air inlet filter (if equipped) in bottom of charcoal canister every 30,000 miles. Regular inspection should be made and defective components replaced as necessary.

FUEL INJECTION SYSTEM - MULTI-POINT

1988 Jeep Cherokee

1988 Electronic Fuel Injection
JEEP MULTI-POINT

4.0L Cherokee, Comanche, Wagoneer

DESCRIPTION

The Multi-Point Electronic Fuel Injection (EFI) system is an electronically controlled system which combines electronic sequential fuel injection and electronic spark advance systems. Main sub-systems consist of: air induction, fuel delivery, fuel control, emission control, Electronic Control Unit (ECU), data sensors and switches.

Air induction system includes air cleaner, throttle body, Throttle Position Sensor (TPS) and the Idle Speed Stepper (ISS) motor.

Fuel delivery system provides fuel from fuel pump to the fuel control system. Fuel system is composed of an in-tank electric fuel pump, fuel filter and return line. Power is provided to operate fuel pump through a fuel pump relay located on right inner fender panel.

Fuel control system handles actual fuel delivery into the engine. Fuel pressure regulator maintains a constant fuel pressure of 31-39 psi (2.1-2.7 kg/cm^2). In addition to the regulator, fuel system consists of the fuel rail and 4 fuel injectors. On MPI engine, ECU controls EGR/EVAP solenoid operation.

The ECU is a digital microprocessor computer. ECU receives input signals from various switches and sensors. ECU then computes fuel injector pulse width ("on" time), spark advance, ignition module dwell, idle speed, canister purge cycles, EGR flow and feedback control from this information.

OPERATION

AIR INDUCTION

Air is drawn into combustion chamber through air cleaner and intake manifold. Amount of air entering engine is controlled by position of throttle body valve. Throttle body houses throttle position sensor (TPS) and idle speed solenoid (ISS) motor. TPS is an electrical resistor which is connected to throttle valve. TPS transmits a signal to ECU in relation to throttle valve angle. This signal is used in calculations to determine injector pulse width to provide adequate air/fuel mixture.

ECU controls idle speed by providing appropriate voltage outputs to move ISS motor pin inward or outward to maintain a predetermined idle speed. ECU continuously monitors TPS and ISS motor and issues change commands to injectors to increase or decrease amount of fuel injected.

FUEL DELIVERY

Power to fuel pump relay is supplied from ignition switch when in "ON" or "START" position, at which time the ECU supplies a ground for fuel pump relay. When relay contacts are closed, power is applied to fuel pump.

Fuel is drawn through one end of a roller-type electric fuel pump, compressed and forced out opposite end. Pump capacity is greater than maximum engine consumption so that pressure in fuel system is always maintained.

FUEL CONTROL

Fuel control system handles actual delivery of fuel to engine. See Fig. 1. Fuel from fuel pump enters fuel rail, injectors and pressure regulator. Based upon a manifold vacuum signal, pressure regulator maintains a constant fuel pressure in fuel system of approximately 31-39 psi (2.1-2.7 kg/cm²) by allowing excess fuel to return to fuel tank.

Fuel injectors are electrically operated solenoid valves which are energized by the ECU. The ECU determines injector pulse width ("on" time) based upon input from the various sensors.

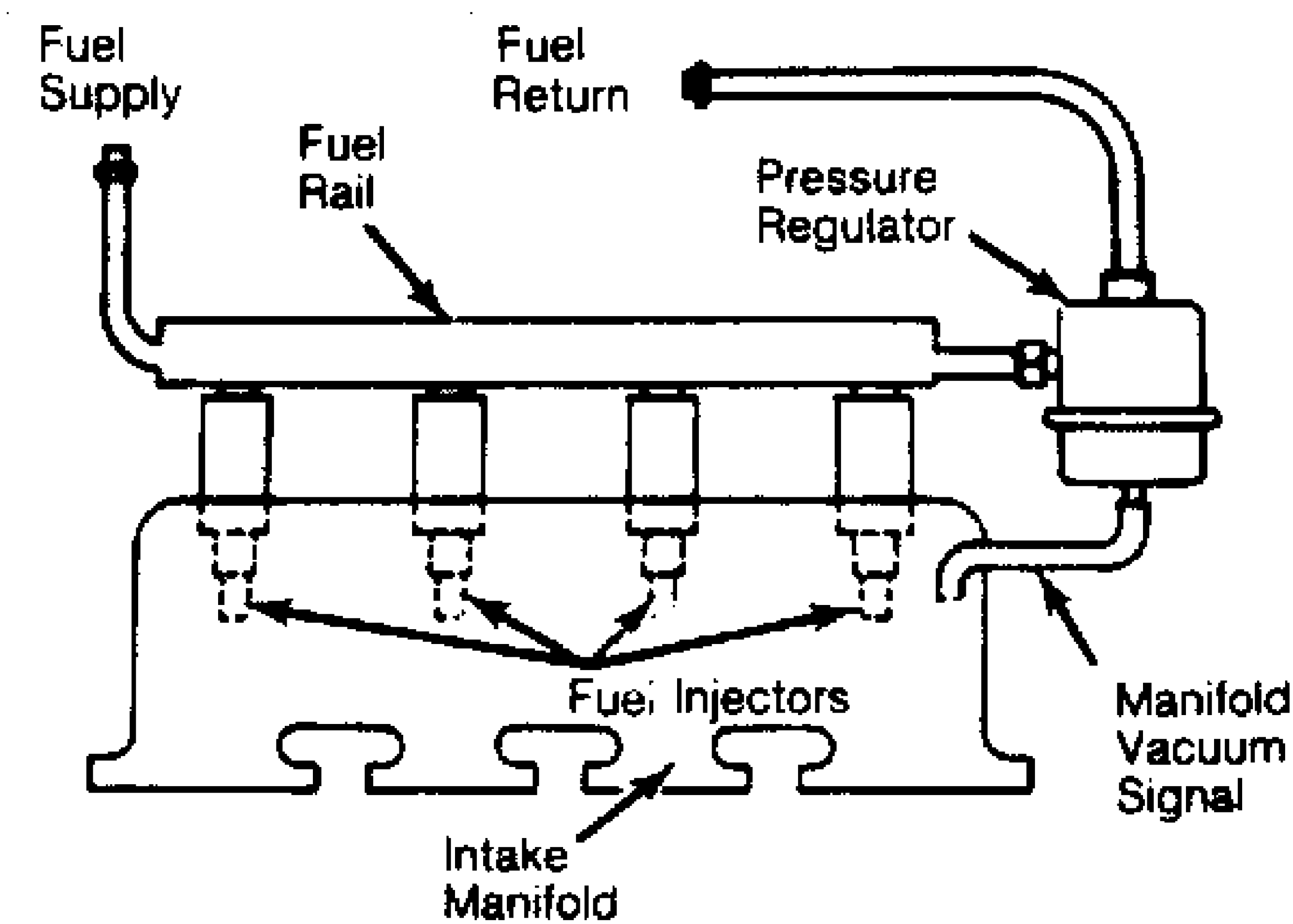


Fig. 1: Fuel Control Components
Courtesy of Chrysler Motors.

EMISSION CONTROL

ECU controls EGR valve and fuel evaporative operation. By energizing the EGR/EVAP solenoid, vacuum is shut off, making this system non-operative. When engine reaches normal operating temperatures, ECU de-energizes solenoid. When de-energized, solenoid allows vacuum to flow to EGR valve. ECU will energize solenoid whenever EGR action is undesirable, during idle, cold engine operation, wide open throttle and rapid acceleration or deceleration.

ELECTRONIC CONTROL UNIT (ECU)

ECU is a digital microprocessor computer. Data sensors provide the ECU with engine operating information in varying electrical signals. ECU calculates this information and corrects air/fuel ratio, ignition timing, and emission control as needed to maintain efficient engine operation. Other ECU output signals control upshift indicator light (manual transmission only), ignition module dwell and A/C clutch operation.

UPSHIFT INDICATOR

On vehicles equipped with a manual transmission, ECU controls upshift indicator light. Indicator light is normally illuminated when ignition is turned on without engine running. Indicator light is turned off when engine is started.

Indicator light will be illuminated during engine operation in response to engine load and speed. If transmission is not shifted, ECU will turn light off after 3 to 5 seconds. A switch located on transmission prevents indicator light from being illuminated when transmission is shifted to highest gear.

DATA SENSORS & SWITCHES

Manifold Absolute Pressure (MAP) Sensor

MAP sensor is located in engine compartment on firewall, behind engine. MAP sensor monitors manifold vacuum via a vacuum line from intake manifold to sensor.

MAP sensor supplies an electrical signal which keeps ECU informed of manifold vacuum and barometric pressure conditions. This information is combined with data supplied by other sensors to determine correct air/fuel ratio.

Oxygen Sensor

Oxygen (O_2) sensor is mounted in exhaust manifold where it is exposed to exhaust gas flow. Its function is to monitor oxygen content of exhaust gases and to supply ECU with a voltage signal directly proportional to this content.

If oxygen content of exhaust gases is high (lean air/fuel mixture), voltage signal to ECU is low. As oxygen content decreases (mixture becomes richer), signal voltage increases.

In this way, ECU is kept constantly informed of air/fuel ratio. ECU can then alter fuel injector "on" time, in response to these signals, to obtain best air/fuel ratio of 14.7:1 under any given operating conditions.

O_2 sensor is equipped with a heating element that keeps sensor at proper operating temperatures. Maintaining correct sensor temperatures at all times guarantees a more accurate signal to ECU. By using an O_2 heater, fuel control system may also enter "closed loop" operating mode sooner and maintain this mode, even during periods of extended idle.

Temperature Sensors

There are 2 temperature sensors used on this system. Manifold Air Temperature (MAT) sensor, mounted in intake manifold, measures temperature of incoming air/fuel mixture and Coolant Temperature Sensor (CTS), located on left side of cylinder block just below the exhaust manifold, measures temperature of engine coolant.

Information provided by these 2 sensors to ECU allows ECU to demand slightly richer air/fuel mixtures and higher idle speeds during cold engine operation.

Throttle Position Sensor (TPS)

TPS is regulated by movement of throttle shaft. It is

mounted on throttle body and senses angle of throttle blade opening.

A voltage signal of up to 5 volts at wide open throttle is produced by TPS. Voltage varies with throttle angle changes. This signal is transmitted to ECU where it is used to adjust air/fuel ratio during acceleration, deceleration, idle, and wide open throttle conditions.

A dual TPS is used on models with automatic transmissions. This dual TPS not only provides ECU with input voltages but also supplies automatic transmission control unit with input signals relative to throttle position.

Knock Sensor

Knock sensor (detonation sensor) is located on lower left side of cylinder block just above oil pan. Knock sensor picks up detonation vibration from engine and converts it to an electrical signal for use by ECU.

ECU uses this information to determine when a change in ignition timing is required. Knock sensor allows for engine operation on either "premium" unleaded or "regular" unleaded fuel.

When knock occurs, ECU retards ignition timing in one or more cylinders until detonation is eliminated.

Speed Sensor

Speed sensor is secured by special shouldered bolts to flywheel/drive plate housing. Speed sensor is nonadjustable and preset at factory. Speed sensor senses TDC and engine speed by detecting flywheel teeth as they pass pick-up coil during engine operation. See Fig. 2.

Flywheel has a large trigger tooth and notch located 12 small teeth before each TDC position. When a small tooth and notch pass the magnetic core in sensor, concentration and collapse of the magnetic field created induces a small voltage spike into sensor pick-up coil windings. These small voltage spikes are sent to ECU, allowing ECU to count the teeth as they pass sensor.

When a large tooth and notch pass magnetic core in sensor, increased concentration and collapse of the magnetic field induces a higher voltage spike than smaller teeth. Higher spike indicates to ECU that a piston will soon be at TDC position, 12 teeth later. Ignition timing for cylinder is either advanced or retarded by ECU based upon "sensor input".

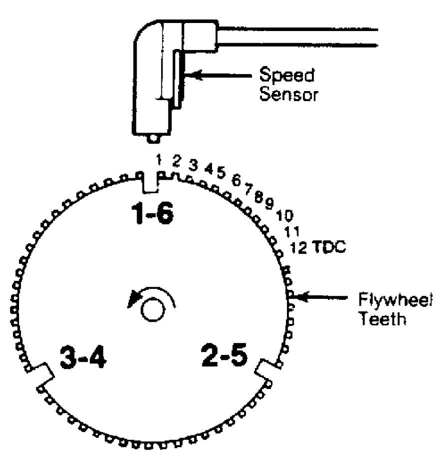


Fig. 2: Speed Sensor Operation
Courtesy of Chrysler Motors.

Engine Switches

Several switches provide operating information to ECU. These

include Park/Neutral switch (automatic transmission only), air conditioning clutch, and Sync Pulse switch. When A/C or Park/Neutral switches supply ECU with an "on" signal, module signals ISS motor to change idle speed to a specific RPM.

With A/C on and throttle blade above a specific angle, ECU de-energizes A/C relay, preventing A/C clutch from engaging until throttle blade angle is reduced.

Sync pulse switch, located within distributor, generates a signal to ECU, helping to properly synchronize sequential fuel injection opening with intake valve opening.

ADJUSTMENTS

NOTE: Idle speed and air/fuel mixture are controlled by ECU and are non-adjustable. On-car adjustment procedures for other components should not be necessary during normal vehicle operation or maintenance. Adjustments of components should only be required when a faulty component is replaced with a new one.

THROTTLE POSITION SENSOR (TPS)

1) Turn ignition on. Check throttle position sensor input voltage. Connect voltmeter negative lead to terminal "B" (M/T), or terminal "D" (A/T) of sensor connector. Connect voltmeter positive lead to terminal "A" (M/T and A/T) of sensor connector.

NOTE: On (A/T) models, connector terminals are identified by letters molded into back of connector. On all models, do not disconnect TPS harness connector. Insert voltmeter test leads through back of wire harness connector. On some models, it may be necessary to remove throttle body from intake manifold to gain access to sensor wire harness.

2) Move and close throttle plate completely (M/T and A/T). Ensure throttle linkage contacts stop. Note voltmeter reading. Input voltage at terminals "B" and "A" (M/T), or terminals "A" and "D" (A/T) should be 5 volts.

3) Return throttle plate to closed throttle position (M/T and A/T). Check sensor output voltage. To do so, disconnect voltmeter positive lead from terminal "A" and connect it to terminal "C" (M/T), or terminal "B" (A/T).

4) Maintain throttle plate in closed position (M/T and A/T). Ensure throttle linkage contacts stop. Note voltmeter reading. Output voltage should be .8 volt (M/T), or 4.2 volts (A/T).

5) If output voltage is incorrect, loosen bottom sensor retaining screw and pivot sensor in adjustment slot for a coarse adjustment. Loosen top sensor retaining screw for fine adjustments. Tighten screws after adjustment.

TESTING & TROUBLE SHOOTING

PRELIMINARY CHECKS & PRECAUTIONS

Subsystem Checks

The following systems and components must be in good condition and operating properly before assuming a fuel injection system malfunction.

* Air filter.
* All support systems and wiring.

* Battery connections and specific gravity.
* Engine Compression.
* Electrical connections on components and sensors.
* Emission control devices.
* Ignition system.
* All vacuum line, fuel hose and pipe connections.

General Precautions

In order to prevent injury to operator or damage to system or component parts, use following techniques:

* Turn ignition off before connecting or disconnecting any component parts.
* DO NOT apply DC voltage greater than 12 volts or any AC voltage to system.
* Disconnect battery cables before charging.
* Remove ECU from vehicle if ambient temperature could exceed 176°F (80°C).
* DO NOT modify or circumvent any system functions.

SYSTEM TESTING

Fuel System Test

WARNING: Always relieve residual fuel pressure in fuel delivery system before opening system. To prevent chance of personal injury, cover fittings with shop towel while disconnecting fittings.

1) Remove cap from pressure test port located in fuel rail. See Fig. 3. Connect Fuel Pressure Gauge (J-34730-1) to pressure fitting.

2) Start vehicle. Pressure should be approximately 31 psi (2.1 kg/cm^2) with vacuum hose connected to pressure regulator and 39 psi (2.6 kg/cm^2) with vacuum hose removed from pressure regulator.

3) Check fuel pump flow rate. A good fuel pump will deliver at least one liter of fuel per minute with fuel return line pinched off. If fuel pump does not pump adequately, inspect fuel system for a plugged fuel filter or filter sock.

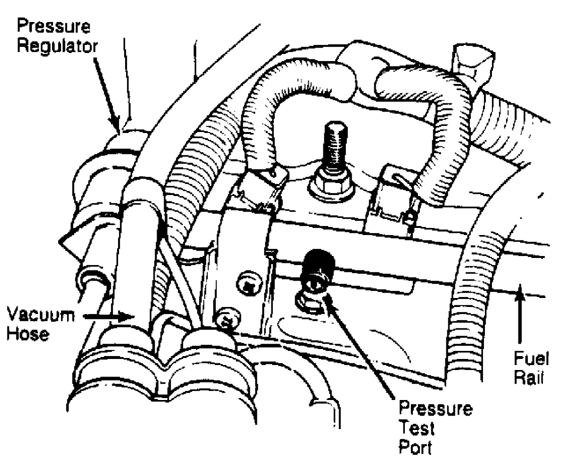


Fig. 3: Fuel System Pressure Test Components
Courtesy of Chrysler Motors.

4) Fuel pump flow rate can be checked by connecting one end of an old A/C gauge hose to fuel test port on fuel rail and inserting

other end of hose into a container of at least one liter or more capacity.

5) Run fuel pump by installing a jumper wire into diagnostic connector terminals D1-5 and D1-6. Be sure to pinch off fuel return line or most of fuel will be returned to fuel tank.

EGR Solenoid Test

1) Verify that vacuum is present at vacuum fitting "C" of EGR solenoid. See Fig. 4. Remove vacuum connector from "A" and "B". Connect a vacuum gauge to "B".

2) Start and idle engine. There should be no vacuum at "B". Disconnect electrical connector "D" from solenoid. There should now be vacuum at "B".

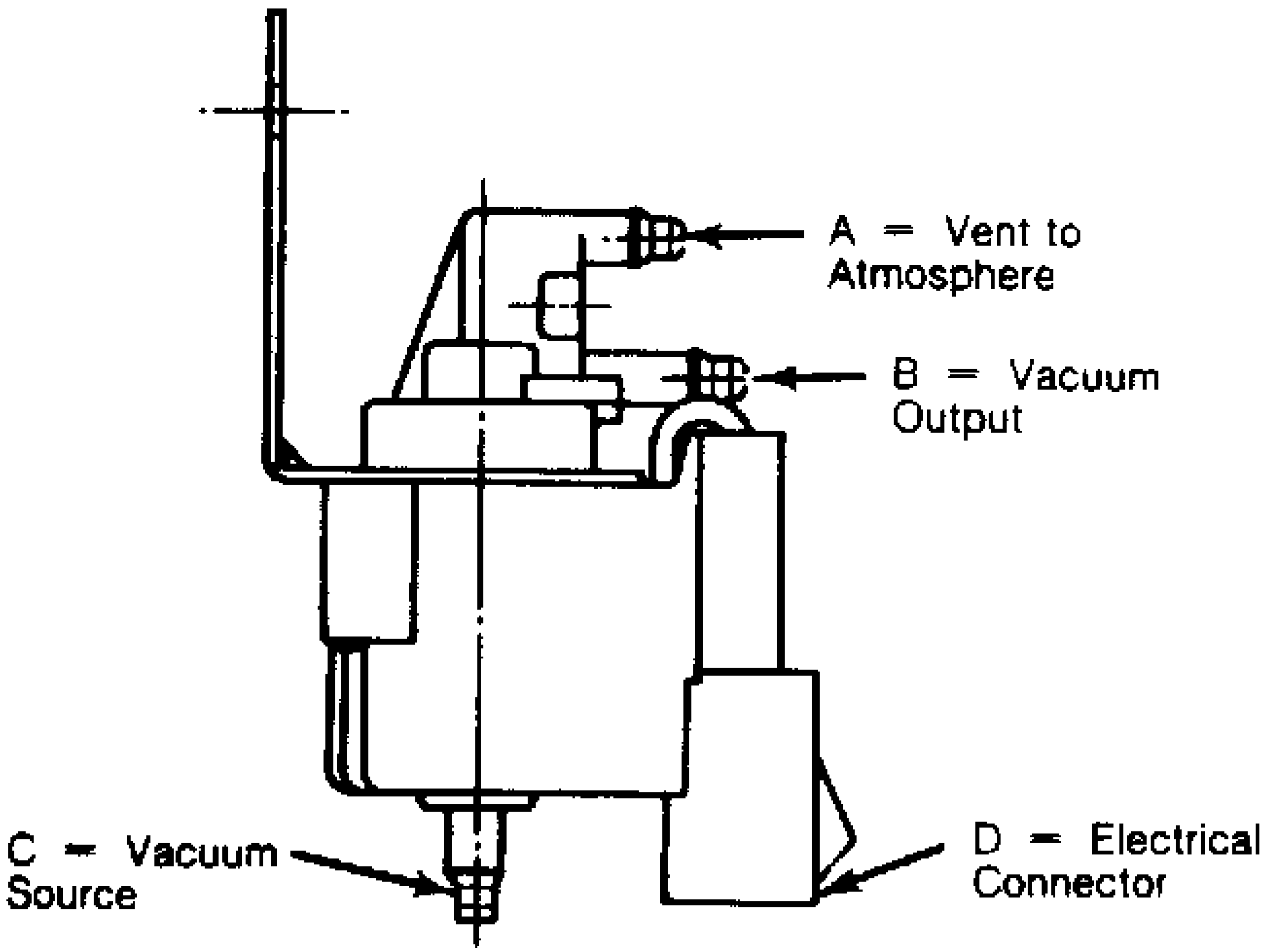


Fig. 4: EGR Solenoid Test Points
Courtesy of Chrysler Motors.

MAP Sensor Test

1) Inspect MAP sensor hoses and connections. Repair as necessary. With ignition on and engine off, test MAP sensor output voltage at connector terminal "B". (Marked on sensor body). See Fig. 5. Output voltage should be 4 to 5 volts.

2) To verify wiring harness condition, test ECU terminal C-6 for same voltage described. Test MAP sensor supply voltage at sensor connector terminal "C" with ignition on.

3) Voltage should be 4.5-5.5 volts. Same voltage should also be at terminal C-14 of ECU wire harness connector. Using Diagnostic Tester (M.S. 1170), test MAP sensor ground circuit at terminal D-3 and terminal "A" of sensor connector.

4) Using an ohmmeter, test MAP sensor ground circuit at ECU connector between terminal D-3 of ECU connector and terminal B-11 with an ohmmeter.

5) If ohmmeter or diagnostic tester indicates an open circuit, inspect for a defective sensor ground connection, located on right side of cylinder block. If ground connection is good, ECU may need to be replaced.

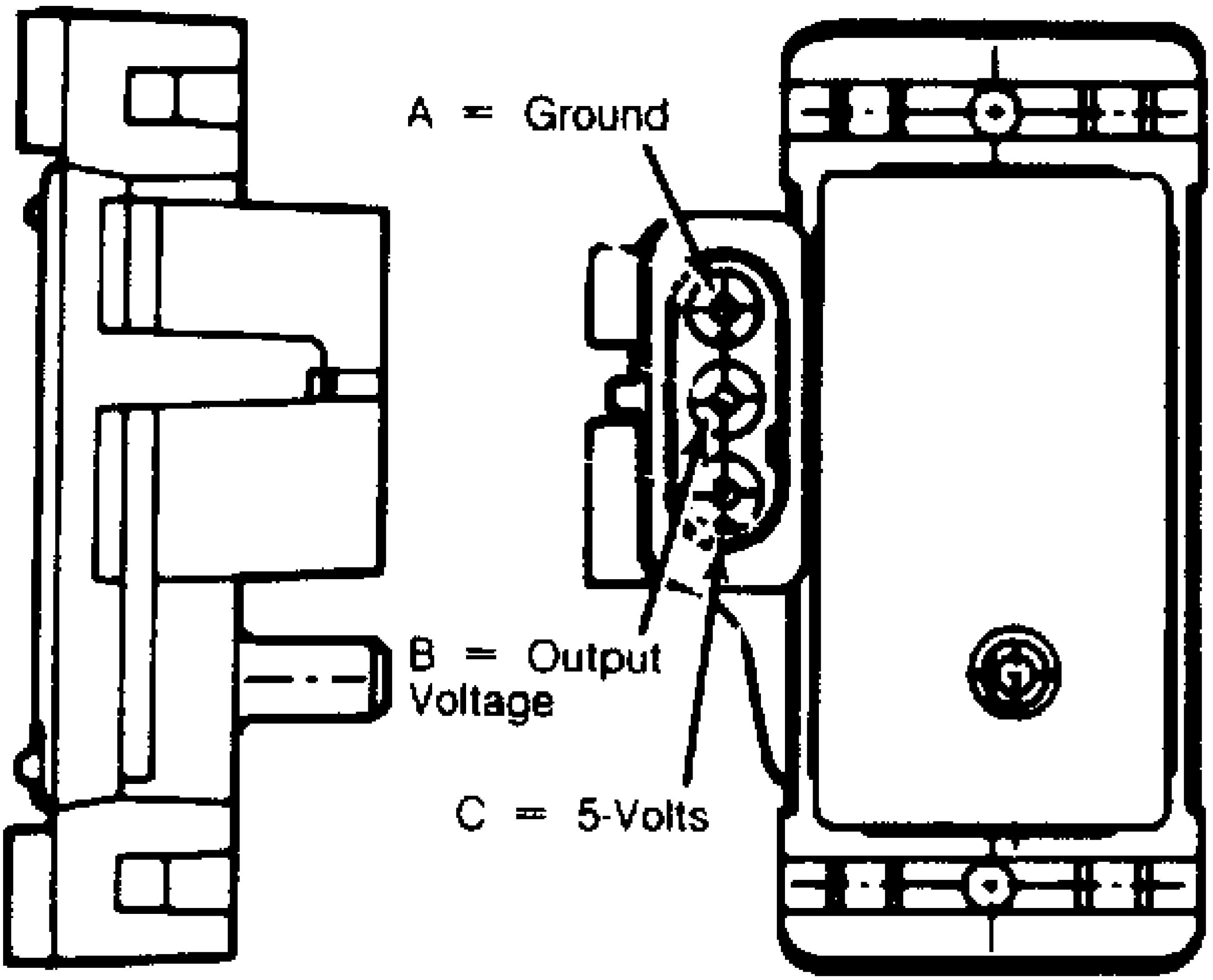


Fig. 5: MAP Sensor Test Points
Courtesy of Chrysler Motors.

O2 Sensor Heating Element Test

Disconnect O2 sensor connector. Connect an ohmmeter to terminals "A" and "B" only (marked on the connector) of O2 sensor connector. Resistance should be between 5 and 7 ohms. Replace sensor if ohmmeter indicates an infinity reading.

CTS Test

1) Disconnect wire harness connector from CTS sensor. Test resistance of sensor with a high impedance digital ohmmeter. Resistance should be less than 1000 ohms with engine warm. See TEMPERATURE-TO-RESISTANCE VALUES table.

2) Test resistance of wire harness between ECU terminal D-3 and sensor connector terminal. Repeat test at terminal C-10 of ECU and sensor connector terminal. Repair wire harness if an open circuit is indicated.

MAT Sensor Test

1) Disconnect wire harness connector from MAT sensor. Test resistance of sensor with a high impedance digital ohmmeter. Resistance should be less than 1000 ohms with engine warm. Replace sensor if resistance is not within specified range. See TEMPERATURE-TO-RESISTANCE VALUES table.

2) Test resistance of wire harness between ECU wire harness connector terminal D-3 and sensor connector terminal. Repeat test with terminal C-8 at ECU and sensor connector terminal. Repair wire harness if an open circuit or resistance is greater than one ohm is indicated.

TPS Test

See THROTTLE POSITION SENSOR TEST PROCEDURE chart in this article.

TEMPERATURE-TO-RESISTANCE VALUES (CTS & MAT SENSOR) TABLE

°F	°C (Approximate)	Ohms
212	100	185
160	70	450
100	38	1600
70	20	3400
40	4	7500
20	-7	13,500
0	-18	25,000
-40	-40	100,700

Knock Sensor Test

1) Start engine until engine reaches normal operating temperature. Connect Diagnostic Tester (M.S. 1700). Observe knock value on tester. Using tip of screw driver, gently tap on cylinder block next to knock sensor and observe knock sensor value on tester.

2) Knock sensor value should increase while tapping on cylinder block. If knock sensor value does not increase while tapping on cylinder block, check knock sensor for proper connection. If connection is good, replace knock sensor.

Speed Sensor Test

Disconnect speed sensor connector from ignition control module. Place an ohmmeter between terminals "A" and "B". (Marked on connector) Reading should be 125-275 ohms with engine hot. Replace sensor if readings are not within specifications.

Idle Speed Stepper (ISS) Motor

1) Set parking brake and block drive wheels. Route all tester cables away from cooling fans, drive belts, pulleys and exhaust system. Always allow engine speed to return to normal before disconnecting testing tools.

2) With ignition off, disconnect ISS motor connector at

throttle body. Connect Exerciser Tool (Part No. 8980 002 646) into ISS motor. See Fig. 6.

3) Connect Red clip to battery positive cable. Connect Black clip to battery negative cable. Red light on exerciser tool will illuminate when properly connected. Start engine.

NOTE: When switch on exerciser tool is in "High" or "Low" position, light on exerciser tool will flash indicating voltage pulses are being sent to ISS motor.

4) Move exerciser tool switch to "High" position. Engine speed should increase. Move switch to "Low" position. Engine speed should decrease. If engine speed increases or decreases while using exerciser tool, ISS motor is functioning properly.

5) Disconnect exerciser tool and reconnect ISS motor connector. If engine speed does not change, turn ignition off and remove ISS motor from throttle body.

6) With ignition off, switch exerciser tool between "High" and "Low" positions. Check movement of ISS motor pintle. Pintle should move in and out. If pintle does not move, replace ISS motor.

7) Start engine and test new ISS motor for proper operation. If pintle operates properly, check ISS motor bore in throttle body for blockage and clean as necessary. Reinstall ISS motor into throttle body.

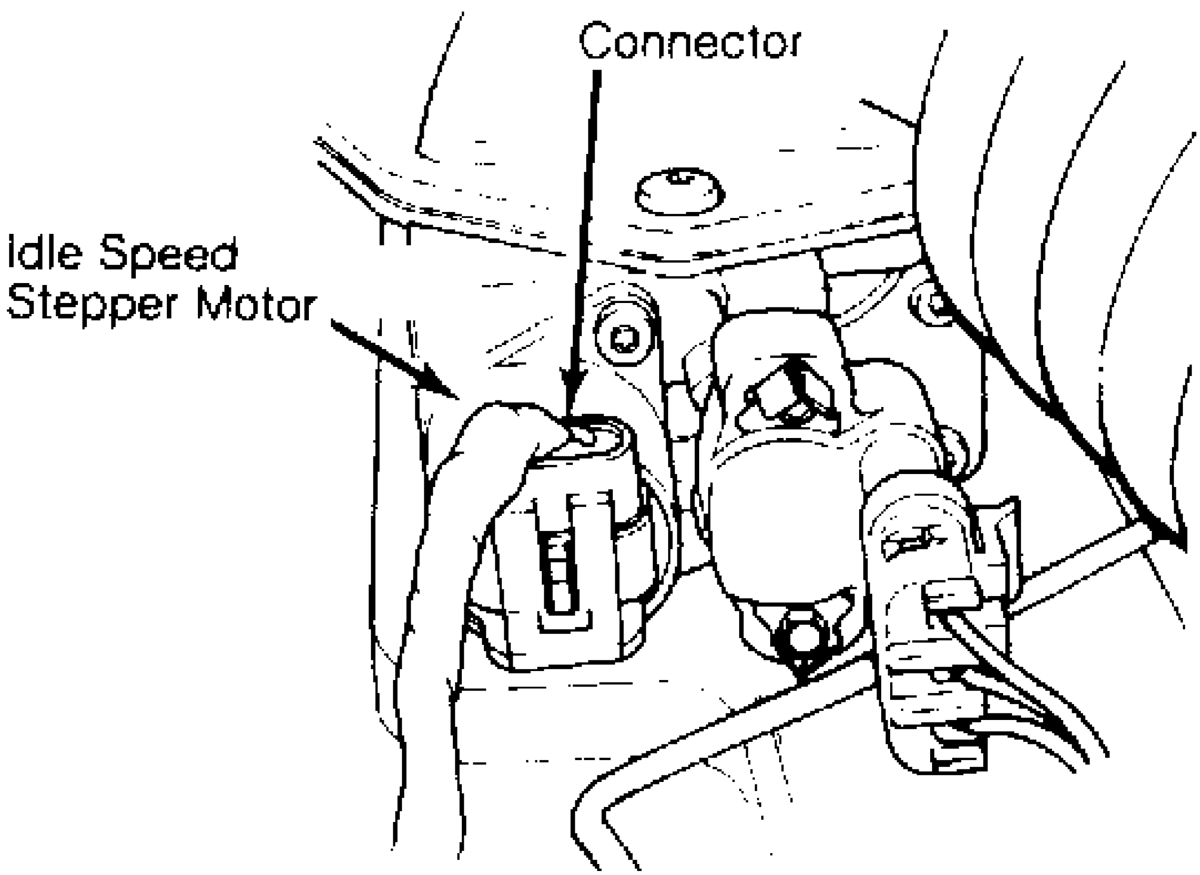


Fig. 6: ISS Motor Test Connector
Courtesy of Chrysler Motors.

Fuel Injector Test

See FUEL INJECTOR TEST PROCEDURE chart in this article.

REMOVAL & INSTALLATION

COOLANT TEMPERATURE SENSOR (CTS)

Removal & Installation

Drain cooling system. Remove air cleaner assembly. Disconnect CTS wire connector. Remove CTS from engine block. Install replacement CTS and connect CTS wire connector. Install air cleaner assembly. Fill cooling system.

OXYGEN SENSOR

Removal & Installation

Raise and support vehicle. Disconnect O2 sensor wire connector. Remove O2 sensor from exhaust manifold. Install O2 sensor and tighten to 30 ft. lbs. (41 N.m). Connect O2 sensor wire connector and lower vehicle.

KNOCK SENSOR

Removal & Installation

Raise and support vehicle. Disconnect knock sensor wire connector. Remove knock sensor from cylinder block. Install knock sensor and connect knock sensor wire connector. Lower vehicle.

SPEED SENSOR

Removal & Installation

Disconnect speed sensor wire connector. Remove 2 speed sensor retaining bolts at transmission housing. Install speed sensor and connect speed sensor wire connector.

STARTER MOTOR RELAY

Removal & Installation

Disconnect negative battery cable. Identify, tag and disconnect wiring to relay. Remove relay retaining screws and remove relay from inner fender panel. Install replacement relay and connect relay wires. Connect negative battery cable. Test relay operation.

MANIFOLD AIR/FUEL TEMPERATURE (MAT) SENSOR

Removal & Installation

Disconnect wire connector from MAT sensor. Remove MAT sensor from intake manifold. To install, reverse removal procedure.

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR

Removal & Installation

Disconnect wire connector, vacuum hose, and retaining nuts from MAP sensor. Remove sensor from firewall. To install, reverse removal procedure.

FUEL INJECTOR

WARNING: Always relieve residual fuel pressure in fuel delivery system before opening system. To prevent chance of personal injury, cover fittings with shop towel while disconnecting fittings.

Removal

Disconnect fuel lines from fuel rail assembly. Disconnect injector wire harness connector. Remove fuel rail retaining bolts. Remove vacuum hose from fuel pressure regulator valve. Remove fuel injector retaining clips and remove fuel injectors. See Fig. 7. On models with (A/T), it may be necessary to remove throttle pressure cable and bracket to remove fuel rail assembly.

NOTE: O-rings must be replaced before fuel lines are reassembled.

Installation

Install fuel injectors into fuel rail assembly and install retaining clips. Position fuel rail onto manifold while lining up injectors with holes in intake manifold. Secure injector retaining bolts. Connect injector wire connectors to proper injectors. Install fuel lines into fuel rail assembly. Connect vacuum hose to pressure regulator. Install throttle pressure bracket and cable (A/T).

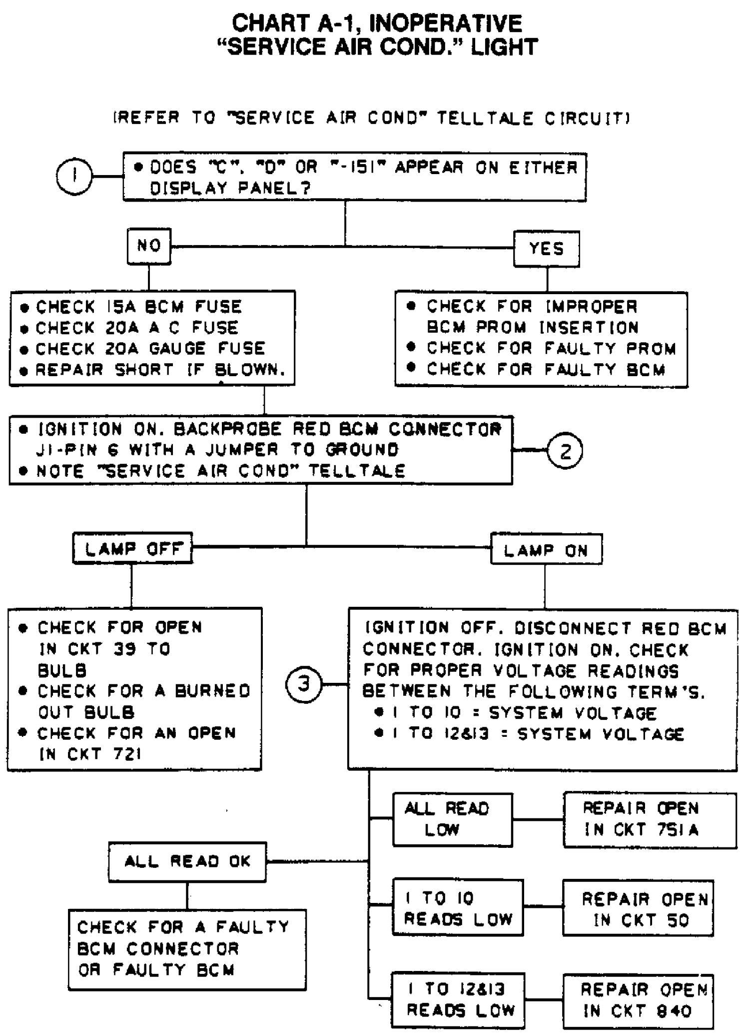


Fig. 7: Fuel Rail Assembly
Courtesy of Chrysler Motors.

FUEL PRESSURE REGULATOR

WARNING: Always relieve residual fuel pressure in fuel delivery system before opening system. To prevent chance of personal injury, cover fittings with shop towel while disconnecting fittings.

Removal & Installation

Remove injector fuel rail assembly. Remove 2 pressure regulator retaining screws. Remove regulator from fuel rail. To install, reverse removal procedure. Adjust regulator after installation.

IDLE SPEED STEPPER (ISS) MOTOR

Removal & Installation

1) Disconnect ISS motor connector. Remove ISS motor retaining screws and ISS motor. To install, reverse removal procedure. No idle speed adjustment is necessary. Idle speed is controlled by the Electronic Control Unit (ECU).

THROTTLE POSITION SENSOR

Removal & Installation

Disconnect TPS wire connector. Bend retaining bolts lock tabs and remove retaining bolts. Remove TPS from throttle plate assembly. To install, reverse removal procedure. Adjust TPS after installation. See ADJUSTMENTS in this article.

EGR VALVE

Removal & Installation

Disconnect vacuum hose from EGR valve. Remove bolts which hold EGR valve to intake manifold. Remove valve and discard gasket. Clean intake manifold gasket mating surface. To install valve, reverse removal procedure. Always use new gasket. See Fig. 8.

CHART B-1, INOPERATIVE "SRVICE AIR COND." LIGHT

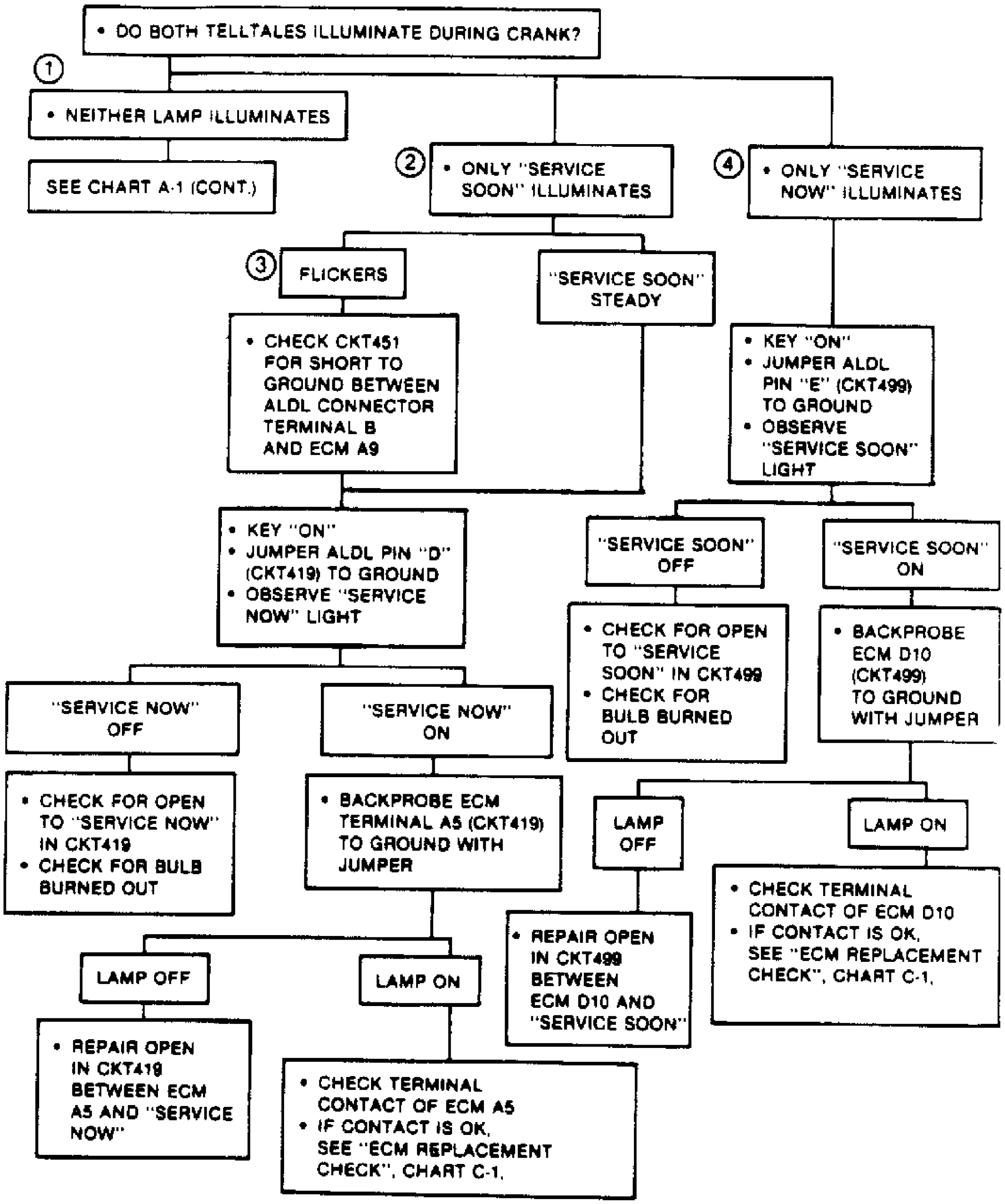


Fig. 8: EGR Valve
Courtesy of Chrysler Motors.

EGR SOLENOID

Disconnect solenoid vacuum hoses. Disconnect solenoid wiring connector. Remove solenoid retaining bolts and solenoid. To install valve, reverse removal procedure.

ECU CONNECTOR PIN IDENTIFICATION 24-PIN CONNECTOR MPFI TABLE

Terminal No.	Wire Function
A1	Injector No. 3
A2	Injector No. 6
A3	Injector No. 2
A4	Injector No. 4
A5	Fuel Pump Relay
A6	Not Used
A7	Oxygen Sensor Relay
A8	Shift Light
A9	Latch Relay
A10	EGR/Evap. Solenoid
A11	Not Used
A12	A/C Relay
B1	Injector No. 1
B2	Injector No. 5
B3	AIS A
B4	AIS A1
B5	AIS C
B6	AIS C1
B7	Battery (Pos.)
B8	Ignition
B9	Not Used
B10	Latched B (Pos.)
B11	Ground
B12	Ground

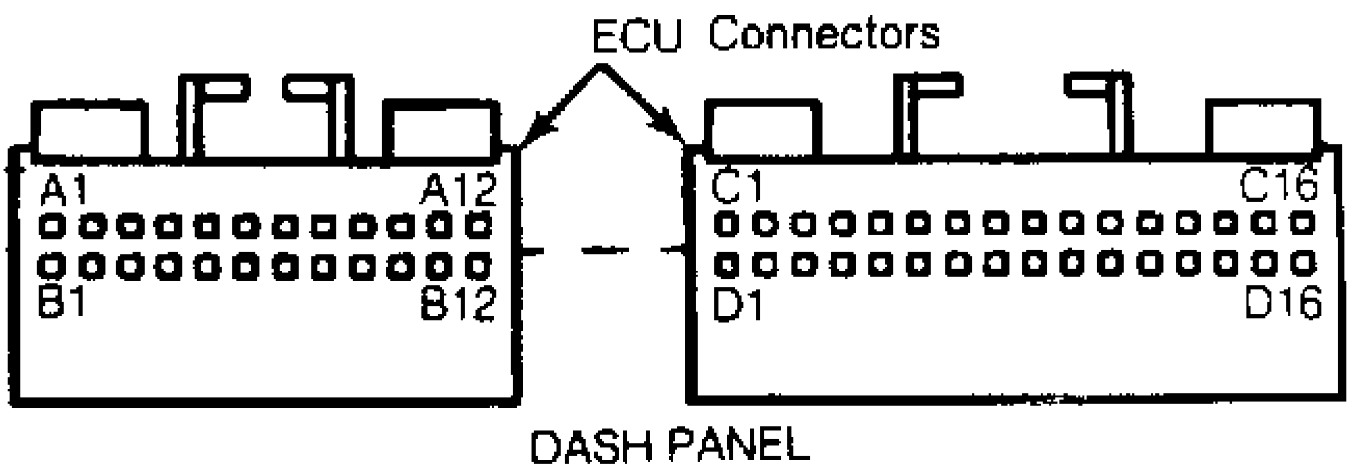


Fig. 9: Multi-Point Injection ECU Connector
Courtesy of Chrysler Motors.

ECU CONNECTOR PIN IDENTIFICATION 32-PIN CONNECTOR MPFI TABLE

Terminal No.	Wire Function
C1	Speed Sensor (Pos.)
C2	A/C Request
C3	Start
C4	P/N Switch
C5	Sync. (Neg.)

C6	MAP Sensor
C7	TPS Sensor
C8	Air Temp. Sensor
C9	Not Used
C10	Coolant Temp. Sensor
C11	Injection Supply
C12	TX Serial Data
C13	Not Used
C14	MAP Sensor Supply Voltage
C15	TPS Supply Voltage
C16	Sync. (Pos.)
D1	Speed Sensor (Neg.)
D2	A/C Select
D3	Sensor Ground
D4	Not Used
D5	Not Used
D6	Not Used
D7	Not Used
D8	Knock Sensor Ground
D9	Oxygen Sensor Input
D10	Injector Supply
D11	RX Serial Data
D12	Not Used
D13	Spark/Dwell
D14	Not Used
D15	Not Used
D16	Knock Sensor

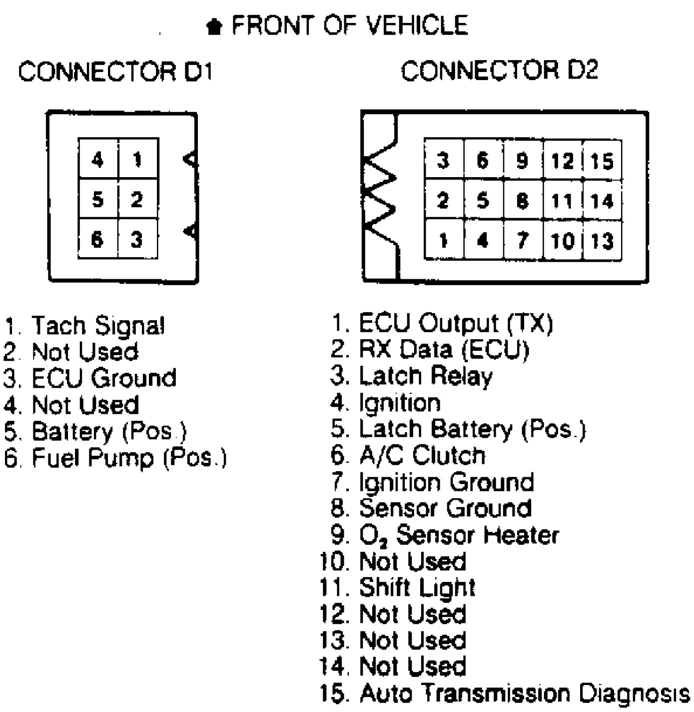


Fig. 10: Multi-Point Injection Diagnostic Connector
Courtesy of Chrysler Motors.

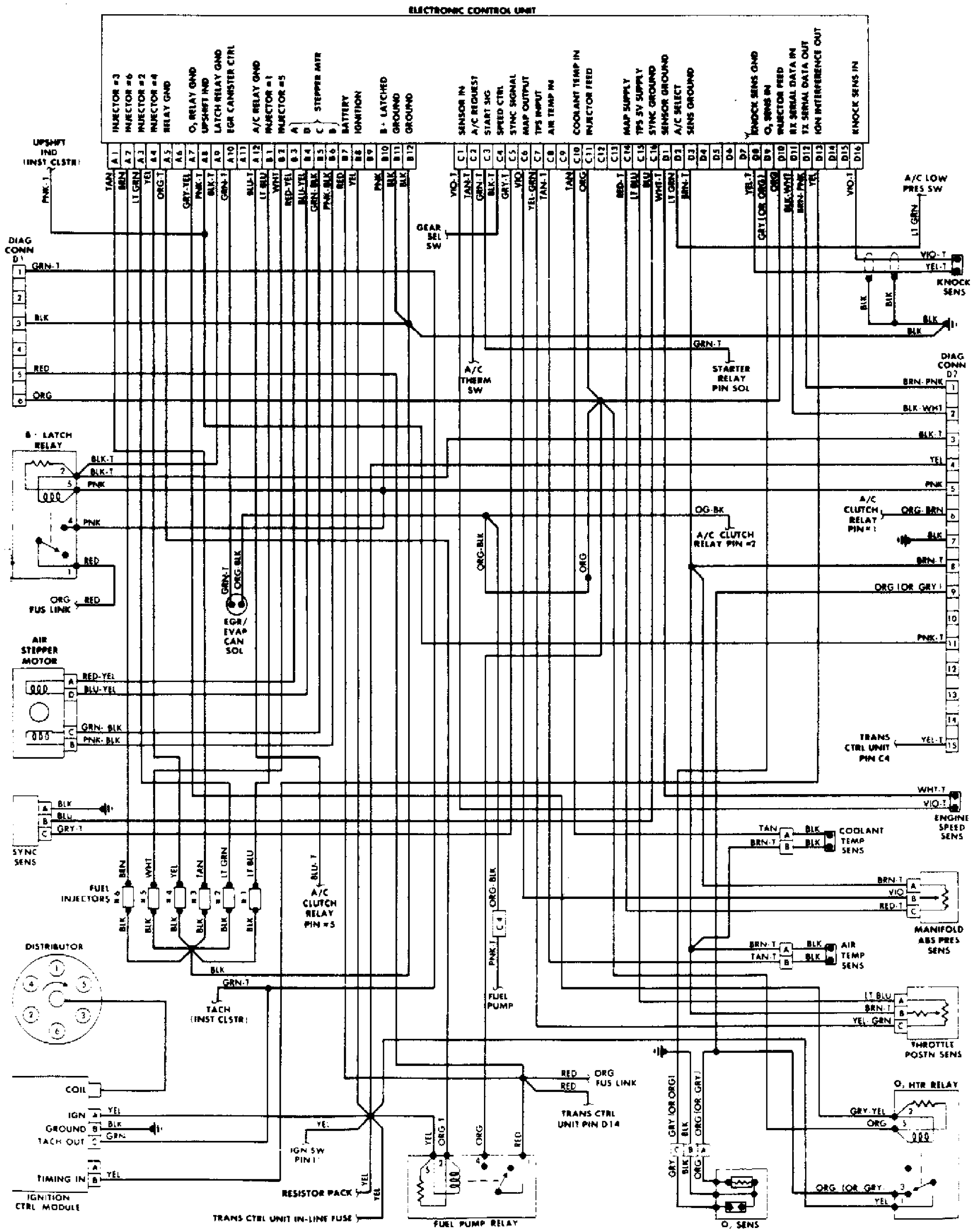
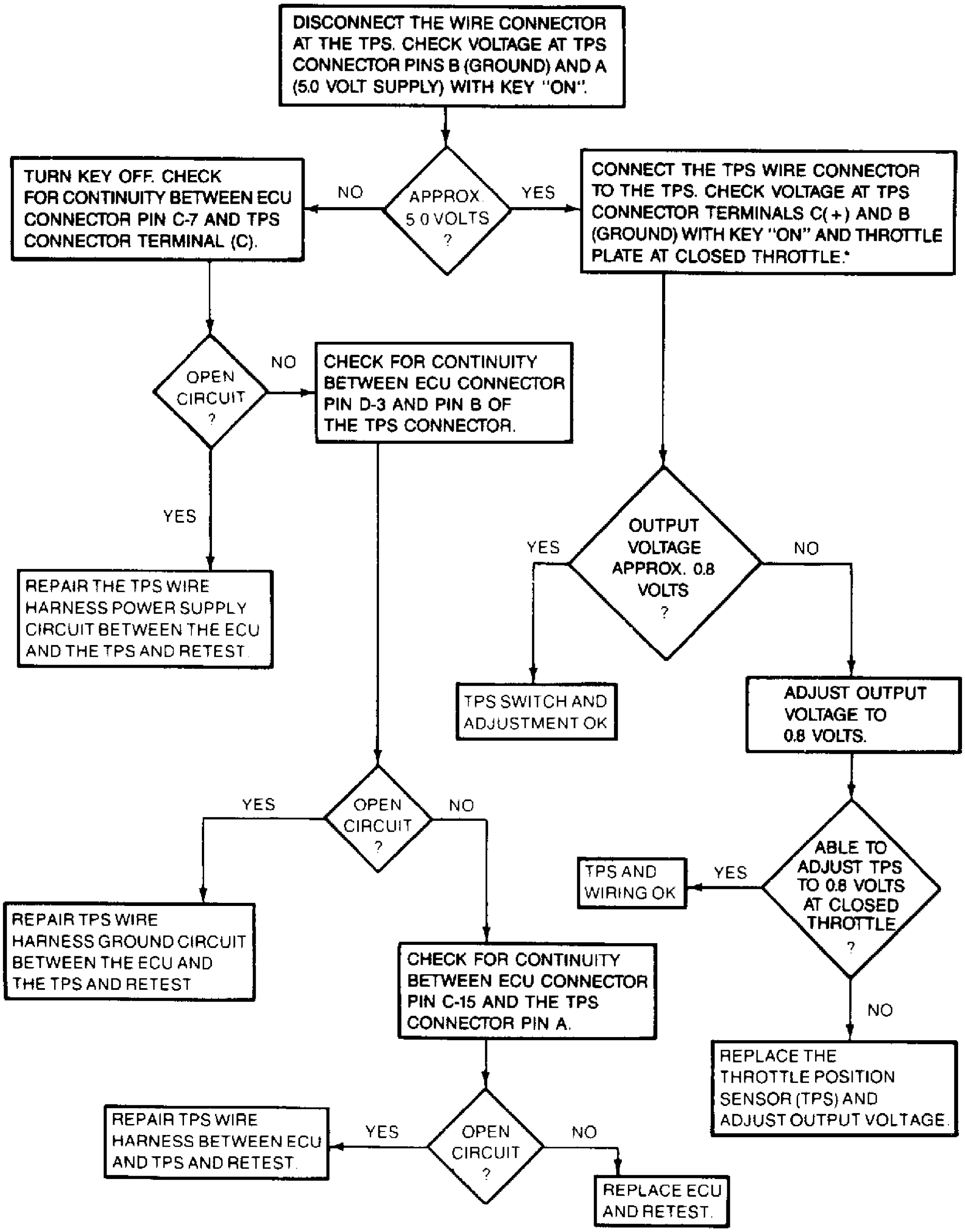


Fig. 11: Comanche Multi-Point Fuel Injection Wiring Diagram
(Wiring Diagram Not Available for Cherokee & Wagoneer Models)



* DO NOT UNFASTEN THE SENSOR WIRE HARNESS CONNECTOR. INSERT THE VOLTMETER TEST LEADS THROUGH THE BACK OF THE WIRE HARNESS CONNECTOR TO MAKE CONTACT WITH THE SENSOR TERMINALS.

Fig. 12: Throttle Position Sensor Test Procedure Chart (M/T)

FUEL INJECTOR TEST PROCEDURE CHART

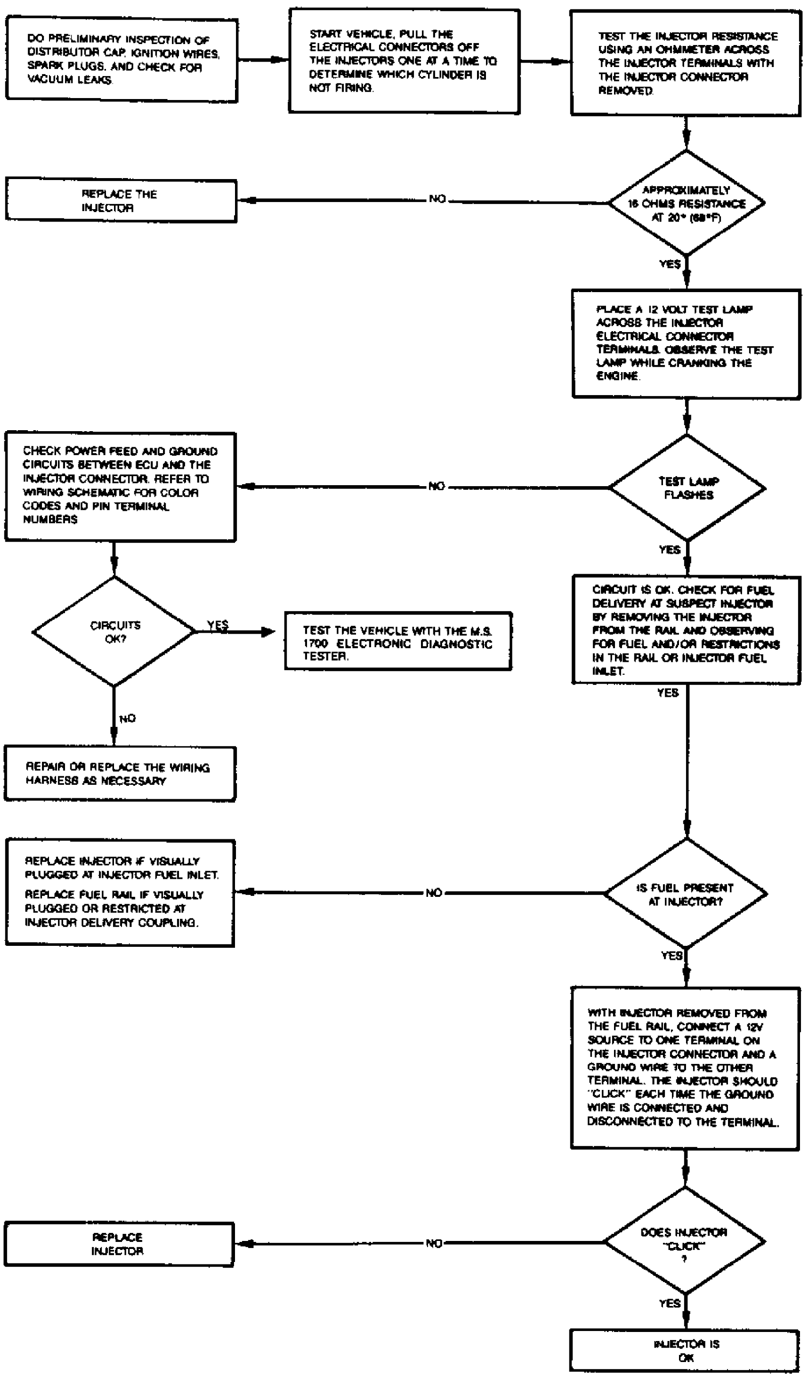


Fig. 13: Fuel Injector Test Procedure Chart

FUEL INJECTION SYSTEM - TBI

1988 Jeep Cherokee

1988 Electronic Fuel Injection
JEEP/RENIX THROTTLE BODY INJECTION

2.5L Cherokee, Comanche, Wagoneer, Wrangler

DESCRIPTION

The Throttle Body Injection (TBI) system is a single injector system that introduces fuel into throttle body from above throttle plate. Fuel injector, located within throttle body, is controlled by the Electronic Control Unit (ECU).

The ECU is a sealed microprocessor that receives input signals from several sensors and other related engine components. Based on these inputs, ECU generates output signals that control and adjust air/fuel mixture and ignition timing as necessary for proper engine performance.

ECU also controls engine idle speed, emission control systems, upshift indicator light (manual transmission only), and A/C compressor clutch.

OPERATION

ELECTRONIC CONTROL UNIT (ECU)

On Cherokee, Comanche and Wagoneer, ECU is located under instrument panel, above accelerator pedal. On Wrangler, ECU is located behind glove box. Input information from various engine sensors to ECU is used to determine engine operating conditions and needs. Battery voltage input is used to ensure that correct output voltage is supplied by ECU during fluctuations in battery voltage.

FUEL INJECTOR

Fuel injector is mounted in throttle body so that fuel is injected into incoming airflow. When injector solenoid is energized, armature and plunger move upward against spring. Check ball above injector nozzle moves off seat and opens small orifice at end of injector.

Fuel supplied to injector is forced around ball and through orifice, resulting in fine spray of fuel. Volume of fuel injected is dependent only on length of time that injector is energized by ECU, as fuel pressure is constant at injector. During cold engine starts, extra fuel is supplied so richer mixture will aid in starting.

FUEL PRESSURE REGULATOR

Fuel pressure regulator is integral part of throttle body. Pressure regulator has a spring chamber that is vented to same pressure as tip of injector. Because differential pressure between injector nozzle and spring chamber is same, only the length of time that injector is energized controls volume of fuel injected.

Fuel pump delivers more fuel than is required by engine. Excess fuel goes to fuel tank from pressure regulator via fuel return hose. Fuel pressure regulator function is mechanical and ECU does not control it.

FUEL PUMP

Electric roller type fuel pump is located in fuel tank. Integral check valve is used to maintain pressure in fuel delivery system after pump stops running. Fuel pump operation is controlled by ECU through a fuel pump relay.

IDLE SPEED ACTUATOR (ISA) MOTOR

ISA motor acts as movable idle stop to change throttle stop angle. Both engine idle speed and deceleration throttle stop angle are set by ISA. ECU controls ISA motor by providing appropriate voltage outputs to produce idle speed or throttle stop angle required for engine operating condition.

OXYGEN (O2) SENSOR

Oxygen sensor is equipped with a heating element that keeps sensor at proper operating temperature at all times. Oxygen sensor is located in exhaust pipe.

Maintaining proper sensor temperature at all times, system enters "Closed Loop" operation sooner and remains in "Closed Loop" during periods of extended idle. Electrical feed to oxygen sensor is through ignition switch.

The ECU receives sensor voltage signal which varies with oxygen content in exhaust gas. Signal is used by ECU as reference for setting air/fuel mixture ratio. ECU varies voltage to injector both to compensate for battery voltage fluctuations and to change duration of injector opening for control of air/fuel mixture.

MANIFOLD AIR/FUEL TEMPERATURE (MAT) SENSOR

MAT sensor provides a signal to ECU that changes depending upon temperature of air/fuel mixture in intake manifold. During high temperature conditions, ECU will compensate for changes in density of air.

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR

MAP sensor measures absolute pressure in intake manifold. Both mixture density and ambient barometric pressure are supplied to ECU by MAP sensor. Sensor is mounted in middle of firewall in engine compartment. Sensor receives manifold pressure information through vacuum line from throttle body. See Fig. 1.

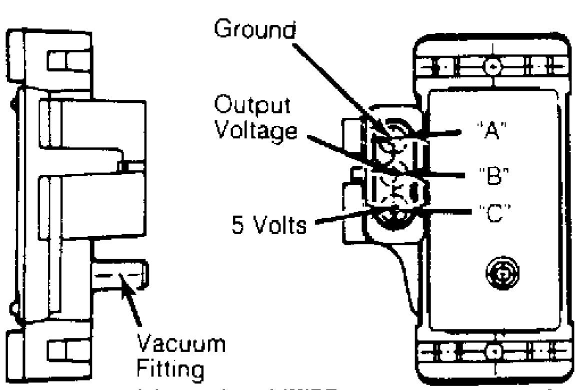


Fig. 1: Manifold Absolute Pressure (MAP) Sensor
Courtesy of Chrysler Motors.

COOLANT TEMPERATURE SENSOR (CTS)

Coolant temperature sensor is installed in intake manifold water jacket to provide coolant temperature input signal for ECU. During cold engine operation, ECU will make mixture richer, make up for fuel condensation in cold intake manifold, increase idle speed during warm-up period, increase ignition advance and keep EGR system inoperative until engine warms up.

THROTTLE POSITION SENSOR (TPS)

Throttle position sensor provides ECU with input signal, up to about 5 volts, to indicate throttle position. This allows ECU to control air/fuel mixture according to throttle position. TPS is mounted on throttle body assembly.

WIDE OPEN THROTTLE (WOT) SWITCH

WOT switch provides an input signal to ECU when engine is at wide open throttle. The ECU enriches air/fuel mixture. The WOT switch is located on the side of throttle body.

CLOSED THROTTLE (IDLE) SWITCH

Idle switch is integral with ISA motor and provides voltage signal to ECU. ECU will signal ISA motor to change throttle stop angle in response to engine operating conditions.

UPSHIFT INDICATOR LIGHT

On vehicles equipped with a manual transmission, ECU controls upshift indicator light. Indicator light is normally illuminated when ignition is turned on without engine running. Indicator light is turned off when engine is started.

Indicator light will be illuminated during engine operation in response to engine load and speed. If transmission is not shifted, ECU will turn light off after 3 to 5 seconds. A switch located on transmission prevents indicator light from being illuminated when transmission is shifted to highest gear.

ENGINE SPEED SENSOR

Engine speed sensor is attached to bellhousing. It senses and counts teeth on flywheel gear ring as they pass during engine operation. Signal from speed sensor provides ECU with engine speed and crankshaft angle. On flywheel gear ring, large trigger tooth and notch is located 90 degrees before each TDC point. Each trigger tooth is followed by 12 smaller teeth and notches before TDC point is reached.

As each of 12 small teeth and notches pass magnetic core in speed sensor, concentration and collapse of magnetic field induces slight voltage (spike) in sensor pick-up coil winding. See Fig. 2. Larger trigger teeth and notches induce higher voltage (spike) in sensor pick-up coil winding. These voltage spikes enable ECU to count teeth as they pass speed sensor.

Higher voltage spike (from larger tooth and notch) indicates to ECU that piston will be at TDC position after 12 smaller voltage spikes have been counted. ECU will then either advance or retard ignition timing depending upon remaining sensor inputs.

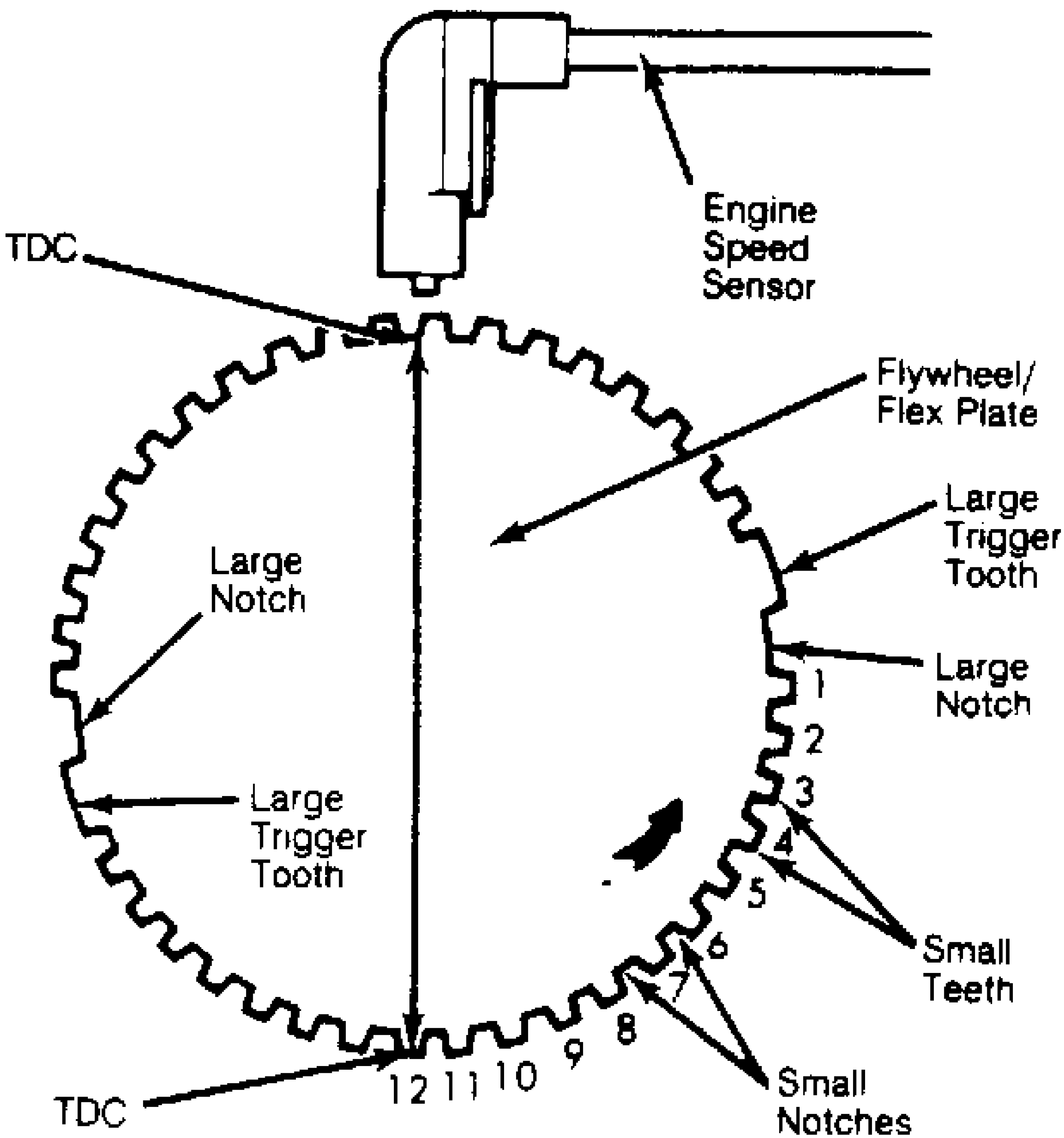


Fig. 2: Engine Speed Sensor
Courtesy of Chrysler Motors.

A/C CONTROLS

ECU receives inputs from A/C when either A/C switch is in "ON" position or compressor clutch engages to lower temperature. ECU changes engine idle speed depending upon A/C compressor operation.

POWER STEERING PRESSURE SWITCH

ECU receives input from pressure switch during periods of high pump load and low engine RPM. Input signals from pressure switch to ECU are routed through A/C request and A/C select input circuits. When pump pressure exceeds 250-300 psi (17.5-21.0 kg/cm^2), switch contacts close transmitting an input signal to ECU. ECU raises engine idle speed immediately after receiving input from pressure switch.

RELAYS

Starter Motor Relay
Starter motor relay provides an input signal to ECU when starter motor is engaged.

System Power Relay
System power relay, located on right fender inner panel, is energized when engine is started. It remains energized for 3 to 5 seconds after ignition is off. This allows ECU to extend ISA for next start before ECU shuts down.

Fuel Pump Control Relay
Fuel pump control relay is located on right fender inner panel. Battery voltage is supplied to relay from ignition switch. When ground is provided by ECU, relay becomes energized and provides voltage to fuel pump.

A/C Compressor Clutch Relay
ECU controls A/C compressor clutch through this relay. The A/C compressor clutch relay is located beside fuel pump control relay on right fender inner panel.

EGR Valve/Canister Purge Solenoid
Vacuum to both EGR valve and vapor canister is controlled by this solenoid. When solenoid is energized, neither EGR valve nor vapor canister receive vacuum.
Solenoid is energized during closed (idle) and wide open throttle operations, engine warm-up and rapid acceleration or deceleration. If solenoid wire connector is disconnected, both EGR valve and vapor canister will receive vacuum at all times.

Load Swap Relay
The load swap relay works in conjunction with power steering switch to disengage A/C compressor clutch. If compressor clutch is engaged when power steering pressure switch contacts close, input signal from switch to ECU also activates load swap relay. Relay then cuts off current to A/C compressor clutch.
The A/C compressor clutch remains disengaged until pressure switch contacts reopen and engine idle returns to normal. The load swap relay contains a timer that delays engaging the compressor clutch for 0.5 second to ensure smooth engagement.

ADJUSTMENTS

CAUTION: When working on or near engine that is running, be very careful to avoid pulleys, belts and fan. DO NOT stand in direct line with blades of fan. DO NOT wear clothing that is loose enough to get caught in moving parts.

IDLE SPEED ACTUATOR (ISA) MOTOR

1) Adjust ISA motor plunger to establish initial position of plunger only if motor has been removed or replaced. Remove air filter elbow and start engine. Run engine until engine reaches normal operating temperature. Turn A/C off (if equipped).

2) Connect tachometer leads to diagnostic connector D1, attaching negative lead to terminal D1-3 and positive lead to terminal D1-1. See Fig. 4. Turn ignition off. ISA motor plunger should move to fully extended position.

3) When ISA motor plunger is fully extended, disconnect ISA motor wiring connector and start engine. Engine speed should be 3300-3700 RPM. If incorrect, turn hex head screw at end of plunger to provide engine speed of 3500 RPM.

4) Fully retract ISA motor by holding closed throttle (idle) switch plunger inward as throttle is opened. Closed throttle switch plunger should not touch throttle lever in closed position. If contact is made, check linkage and/or cable for binding or damage. Repair as necessary.

5) Connect ISA motor wiring harness connector and turn ignition off for 10 seconds. ISA motor should move to fully extended position. Start engine. Engine speed should be 3500 RPM for short period of time and then decrease to normal idle speed.

6) Turn ignition off. Disconnect tachometer. After final adjustment of ISA motor, use thread penetrating sealant (Loctite 290) on adjustment screw to prevent movement and maintain adjustment.

NOTE: If adjustment screw must be moved after thread sealant hardens, loosen threads by heating screw with flameless heat such as soldering gun. DO NOT use flame or torch type of heat as damage to ISA motor will result.

FUEL PRESSURE REGULATOR

WARNING: Always relieve residual fuel pressure in fuel delivery system before opening system. To prevent chance of personal injury, cover fittings with shop towel while disconnecting fittings.

1) Replacement fuel pressure regulator must be adjusted to establish correct pressure. Remove air filter elbow and hose. Connect tachometer leads to diagnostic connector D1, attaching negative lead to terminal D1-3 and positive lead to terminal D1-1. See Fig. 4. Remove screw plug and install fuel pressure test fitting.

NOTE: Fuel pressure test fitting is not included with throttle body. Fitting (8983 501 572) must be obtained separately.

2) Connect fuel pressure gauge to test fitting. Start engine and increase speed to approximately 2000 RPM. Turn Torx head screw at bottom of regulator to set correct pressure. Turning screw inward increases pressure and turning screw outward decreases pressure. See Fig. 3.

3) All models require fuel pressure of 14.5 psi (1.0 kg/cm^2). Install lead sealing ball to cover regulator adjustment screw after adjusting fuel pressure. Turn ignition off. Remove measuring equipment and test fitting. Install original plug screw and air filter assembly.

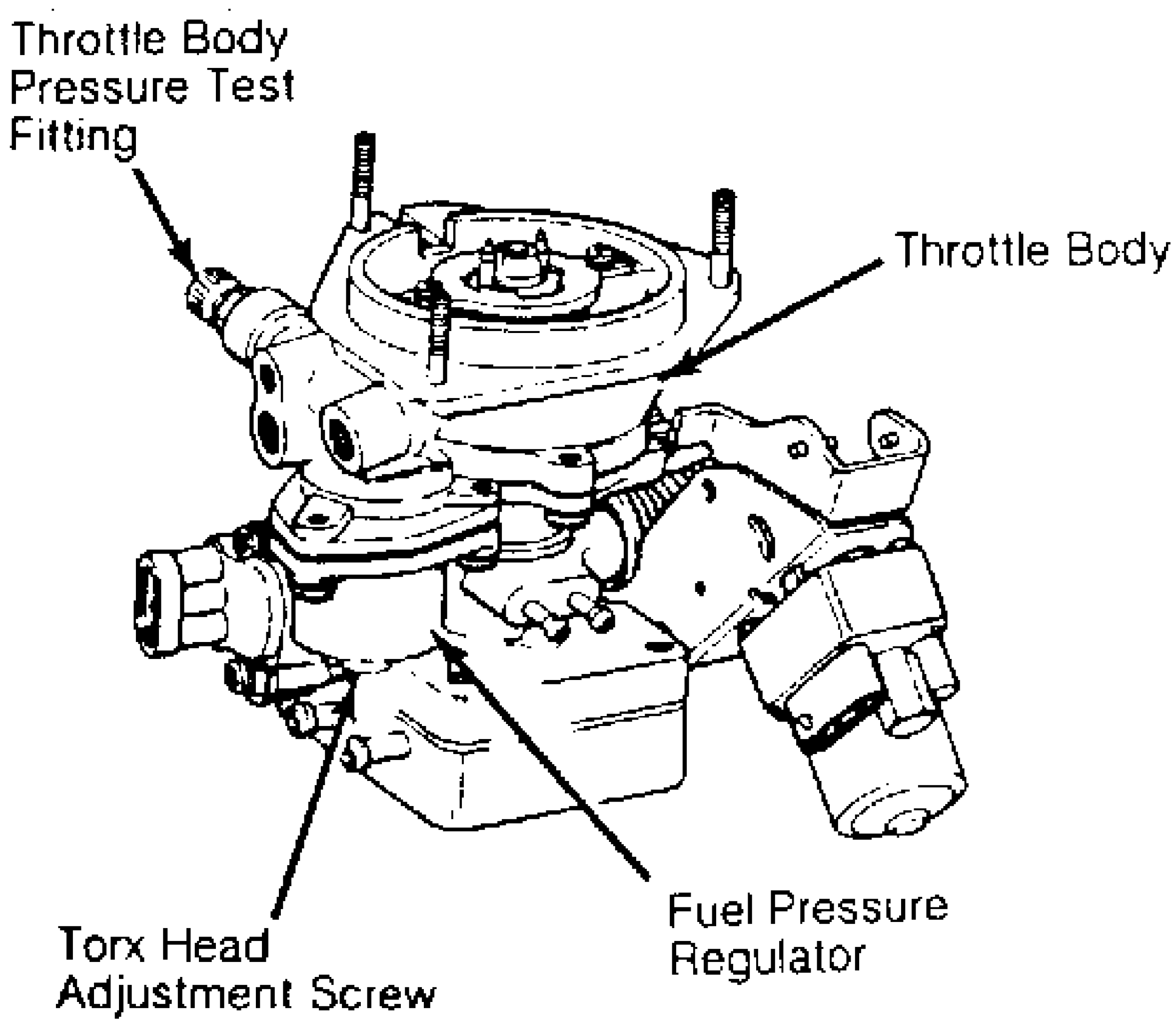


Fig. 3: Adjusting Fuel Pressure Regulator
Courtesy of Chrysler Motors.

THROTTLE POSITION SENSOR (TPS)

1) Turn ignition on. Check throttle position sensor input voltage. Connect voltmeter negative lead to terminal "B" (M/T), or terminal "D" (A/T) of sensor connector. Connect voltmeter positive lead to terminal "C" (M/T), or terminal "A" (A/T) of sensor connector.

NOTE: On (A/T) models, connector terminals are identified by letters molded into back of connector. On all models, do not disconnect TPS harness connector. Insert voltmeter test leads through back of wire harness connector. On some models, it may be necessary to remove throttle body from intake manifold to gain access to sensor wire harness.

2) Move and hold throttle plate at wide open throttle position (M/T), or close throttle plate completely (A/T). Ensure throttle linkage contacts stop. Note voltmeter reading. Input voltage at terminals "B" and "C" (M/T), or terminals "A" and "D" (A/T) should be 5 volts.

3) Return throttle plate to closed throttle position (M/T), or maintain throttle plate in closed position (A/T). Check sensor output voltage. To do so, disconnect voltmeter positive lead from terminal "C" and connect it to terminal "A" (top) of sensor (M/T), or from terminal "A" and connect it to terminal "B" (A/T).

4) Move and hold throttle plate in wide open throttle position (M/T), or maintain throttle plate in closed position (A/T). Ensure throttle linkage contacts stop. Note voltmeter reading. Output voltage should be 4.6-4.7 volts (M/T), or .2 volt (A/T).

5) If output voltage is incorrect, loosen bottom sensor retaining screw and pivot sensor in adjustment slot for a coarse adjustment. Loosen top sensor retaining screw for fine adjustments. Tighten screws after adjustment.

TESTING & TROUBLE SHOOTING

PRELIMINARY CHECKS & PRECAUTIONS

Subsystem Checks

Before testing fuel injection system for cause of malfunction, check that following subsystems and components are in good operating condition:

* Battery and charging system.
* Engine state of tune.
* Emission control devices.
* Fuel system pressure and delivery volume.
* Wiring connectors at components.

General Precautions

In order to prevent injury to operator or damage to system or component parts, use following techniques:

* Turn ignition off before connecting or disconnecting any component parts.
* DO NOT apply DC voltage greater than 12 volts or any AC voltage to system.
* Disconnect battery cables before charging.
* Remove ECU from vehicle if ambient temperature could exceed 176°F (80°C).
* DO NOT modify or circumvent any system functions.

RESISTANCE & VOLTAGE TESTS

MAT Sensor

1) Disconnect wiring from MAT sensor. Using high input impedance digital volt-ohmmeter (DVOM), check resistance of sensor. Resistance should be less than 1000 ohms when engine is warm. Replace sensor if it does not fall within range shown in TEMPERATURE-TO-RESISTANCE VALUES table.

2) Test resistance in wiring harness between ECU connector terminal No. 32 and sensor connector terminal. Also test resistance in wiring harness between ECU harness terminal No. 14 and sensor connector terminal. See Fig. 5. Repair wiring harness if open circuit or resistance greater than one ohm is indicated.

Coolant Temperature Sensor (CTS)

1) Disconnect wiring harness from CTS. Using high input impedance digital volt-ohmmeter (DVOM), check resistance of sensor. Resistance should be less than 1000 ohms when engine is warm. Replace sensor if it does not fall within range shown in TEMPERATURE-to-RESISTANCE VALUES table.

2) Test resistance in wiring harness between ECU harn terminal No. 32 and sensor connector terminal. Also test resistance in wiring harness between ECU harness terminal No. 15 and sensor connector terminal. See Fig. 5. Repair wiring harness if open circuit or resistance greater than one ohm is indicated.

TEMPERATURE-TO-RESISTANCE VALUES (CTS & MAT SENSOR) TABLE

°F	°C (Approximate)	Ohms
212	100	185
160	70	450
100	38	1600
70	20	3400
40	4	7500
20	-7	13,500
0	-18	25,000
-40	-40	100,700

Throttle Position Sensor (TPS) Test

Turn ignition on. Check voltage at terminal connector without disconnecting from TPS. Terminal "A" (M/T), or terminal "B" (A/T) is output voltage, which should be 4.6-4.7 volts at wide open throttle (M/T), or .2 volt at closed throttle (A/T). Terminal "B" (M/T), or terminal "A" (A/T) is sensor ground. Terminal "C" (M/T), or terminal "D" (A/T) is input voltage, which is about 5 volts.

Closed Throttle (Idle) Switch Test

NOTE: ALL testing of idle switch must be done with ISA motor plunger in fully extended position. If switch cannot be tested without extending plunger, it is possible that ISA motor has failed. See IDLE SPEED ACTUATOR MOTOR ADJUSTMENT.

1) Turn ignition on. Check idle switch voltage at diagnostic connector D2, between terminals No. 13 and 7. See Fig. 4. At closed throttle, voltage should be near zero volts. When switch is off closed throttle position, voltage reading should be greater than 2 volts.

2) If voltage is always zero, test for short to ground in harness or switch. Also check for open circuit between switch and terminal No. 25 of ECU connector. If reading is always greater than 2 volts, check for open circuit in wiring harness between switch connector and ECU. Also check for open between ground and switch connector. Replace or repair wiring harness as necessary.

Manifold Absolute Pressure (MAP) Sensor Test

1) Check and repair vacuum hose connections at throttle body and MAP sensor. Check output voltage at MAP sensor connector terminal "B" (marked on sensor body) with ignition on, engine off. Voltage reading should be 4-5 volts. If engine is hot and idling in Neutral, reading should be 1.5-2.1 volts. Check voltage at terminal No. 33 of ECU connector. Reading should be same as that at terminal "B" on MAP sensor connector. See Fig. 4.

2) With ignition on, check MAP sensor supply voltage at terminal "C". Reading should be 4.5-5.5 volts. Same voltage reading should be obtained at terminal No. 16 on ECU harness connector. If necessary, repair or replace wiring harness. Using Diagnostic Tester (MS 1700), test ECU if necessary. Check MAP sensor ground circuit at terminal "A" and terminal No. 17 of ECU connector. Repair wiring if necessary.

3) Using ohmmeter, check MAP sensor ground circuit between terminals No. 17 and 2 of ECU connector. If circuit is incomplete, check sensor ground connection on bellhousing, near starter motor. Replace ECU if ground is good. If terminal No. 17 is shorted to 12 volts, repair problem BEFORE ECU is replaced.

DIAGNOSTIC TOOLS

To properly test throttle body fuel injection system, service technician must have the following equipment available:

* Digital volt-ohmmeter (DVOM) or volt-ohmmeter with minimum input impedance of one megohm.
* 12-volt test light, jumper wires and probes.
* Hand vacuum pump with gauge.
* Ignition timing light.

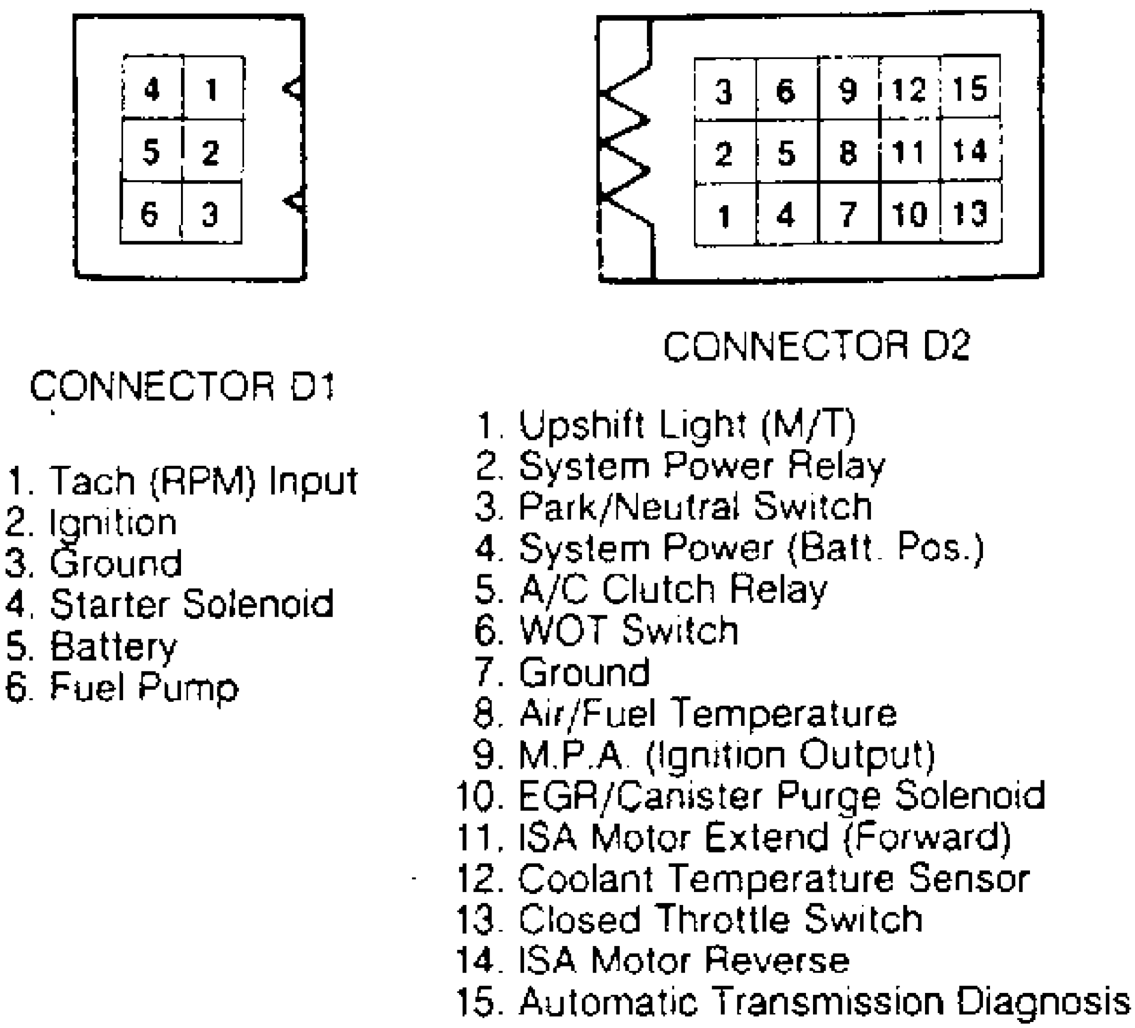


Fig. 4: Jeep/Renix Fuel Injection Diagnostic Connectors
Courtesy of Chrysler Motors.

DIAGNOSTIC TESTS

NOTE: When diagnosing fuel system problems using following procedures, no specialized service equipment is needed. Following diagnostic procedures are NOT applicable if special tester M.S. 1700 is used.

Six different test flow charts are used to fully evaluate fuel injection system:

TEST 1: IGNITION OFF
This test checks that system power provides for ECU memory keep-alive voltage.

TEST 2: IGNITION ON: POWER
This test checks system power function and fuel pump power function.

TEST 3 & 3A: IGNITION ON: INPUT
These tests check the following components and their circuits: closed throttle (idle) switch, Throttle Position Sensor (TPS), MAP sensor, A/T gear selector switch, Coolant Temperature Sensor (CTS) and MAT sensor. Coolant temperature and MAT sensors are tested in cold condition. This procedure also checks all interrelated wiring circuits as well.

TEST 4 & TEST 4A: SYSTEM OPERATIONAL
These tests check engine start-up circuit, fuel injector, "Closed Loop" air/fuel mixture function, coolant temperature sensor function, MAT sensor function, detonation sensor "Closed Loop" ignition retard/advance function, EGR valve and canister purge solenoid function, idle speed control and A/C control functions.

TEST 5: BASIC ENGINE
This test indicates failures in related engine components that are not part of fuel injection system.

TEST 6: MANUAL TRANSMISSION UPSHIFT
This test checks upshift indicator light function on vehicles with manual transmissions.

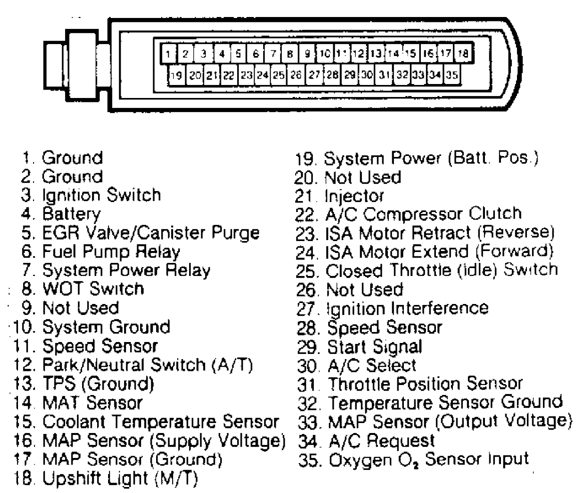


Fig. 5: Jeep/Renix Fuel Injection ECU Connector
Courtesy of Chrysler Motors.

REMOVAL & INSTALLATION

COOLANT TEMPERATURE SENSOR (CTS)

Removal & Installation

Allow engine to cool down. Disconnect CTS wiring harness. Remove CTS from intake manifold and rapidly plug hole to prevent coolant loss. Install replacement CTS and connect CTS wiring harness.

FUEL INJECTOR

WARNING: Always relieve residual fuel pressure in fuel delivery system before opening system. To prevent chance of personal injury, cover fittings with shop towel while disconnecting fittings.

Removal

Remove air cleaner assemby. Remove injector wiring connector. Remove injector retainer screws and clip. Using small pliers, carefully grasp center collar of injector between electrical terminals and carefully remove injector with lifting/twisting motion. Discard both "O" rings. See Fig. 6.

Installation

1) Using light oil, lubricate new upper and lower "O" rings. Install "O" rings in housing bore. Install back-up ring over upper "O" ring. Position replacement injector in fuel body.

2) Center nozzle in lower housing bore and use a pushing/twisting motion to seat injector. Align wire connectors in proper orientation. Install retainer clip and screws. Connect injector wiring. Install air cleaner.

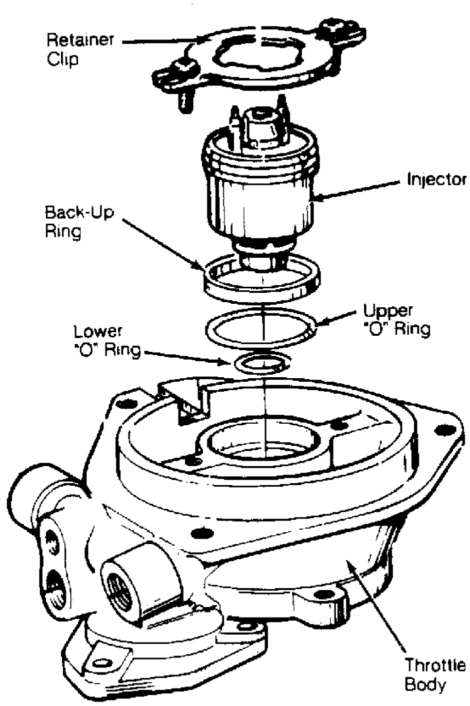


Fig. 6: Fuel Injector & Throttle Body Assembly
Courtesy of Chrysler Motors.

FUEL PRESSURE REGULATOR

Removal & Installation

WARNING: Always relieve residual fuel pressure in fuel delivery system before opening system. To prevent chance of personal injury, cover fittings with shop towel while disconnecting fittings.

With throttle body assembly removed, remove 3 screws holding fuel pressure regulator in throttle body. Remove fuel pressure regulator assembly. Note location of components for installation. Discard gaskets. To install, reverse removal procedure. Adjust regulator after installation. See ADJUSTMENTS in this article.

IDLE SPEED ACTUATOR (ISA) MOTOR

Removal & Installation

1) Disconnect throttle return spring. Disconnect wiring harness connector from ISA motor. Remove ISA motor retaining nuts and remove ISA motor from bracket.

2) To install ISA motor assembly, reverse removal procedure. Adjust ISA motor after installation. See ADJUSTMENTS in this article.

THROTTLE BODY ASSEMBLY

Removal

1) Remove air inlet duct and adapter plate. Remove throttle cable and return spring. Disconnect electrical leads from fuel injector, WOT switch, and ISA motor.

2) Disconnect fuel supply and return lines at throttle body. See Fig. 7. Tag and disconnect vacuum hoses. Disconnect TPS wiring. Remove throttle body assembly. If throttle body assembly is being replaced, transfer ISA motor and WOT switch bracket assembly to new unit.

Installation

Install replacement throttle body assembly on manifold using new gasket. Reconnect all hoses, wires and cable in reverse order of disassembly. Adjust ISA motor after installation. See ADJUSTMENTS in this article.

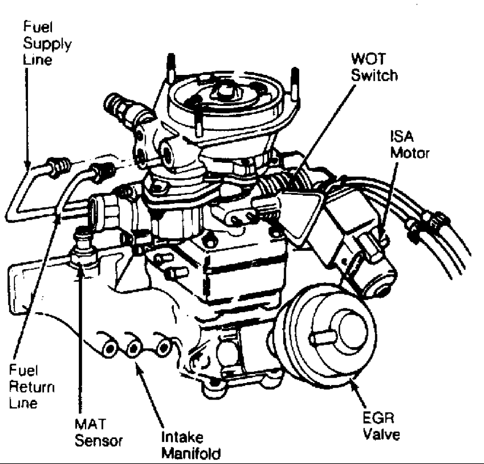


Fig. 7: Intake Manifold & Throttle Body Assembly
Courtesy of Chrysler Motors.

THROTTLE POSITION SENSOR

Removal & Installation

Remove throttle body assembly as previously described. Remove Torx head retaining screws. Remove throttle position sensor from throttle shaft lever. To install, reverse removal procedure. Adjust TPS after installation. See ADJUSTMENTS in this article.

MANIFOLD AIR/FUEL TEMPERATURE (MAT) SENSOR

Removal & Installation

Disconnect wire harness connector from MAT sensor. Remove MAT sensor from intake manifold. To install, reverse removal procedure. See Fig. 7.

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR

Removal & Installation

Disconnect wire harness connector, vacuum hose, and retaining nuts from MAP sensor. Remove sensor from firewall. To install, reverse removal procedure.

ELECTRONIC CONTROL UNIT (ECU)

Removal & Installation

1) On Wrangler, remove passenger assist handle and glove box assembly. Remove ECU bracket retaining nuts from engine compartment side of firewall. Disconnect ECU wiring harness. Remove ECU from bracket. To install, reverse removal procedure.

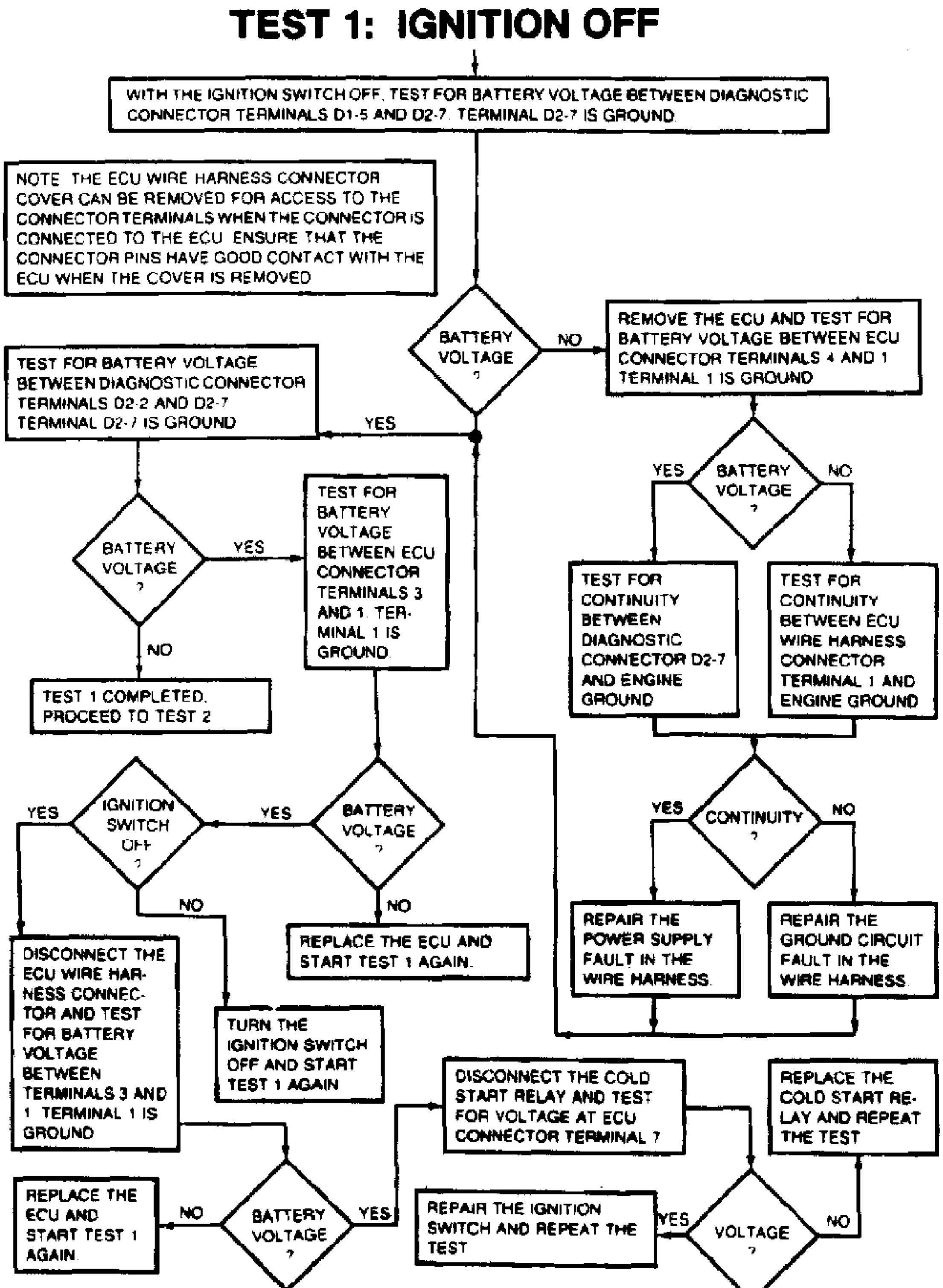
2) On all other models, remove retaining screws and bracket that supports ECU above accelerator pedal. Remove ECU and disconnect wiring harness. To install, reverse removal procedure.

EGR VALVE

Removal & Installation

Disconnect vacuum hose from EGR valve. Remove bolts which hold EGR valve to intake manifold. Remove valve and discard gasket. To install valve, reverse removal procedure. Always use new gasket. See Fig. 7.

TROUBLESHOOTING AND DIAGNOSIS



36961
Fig. 8: TEST 1: IGNITION OFF

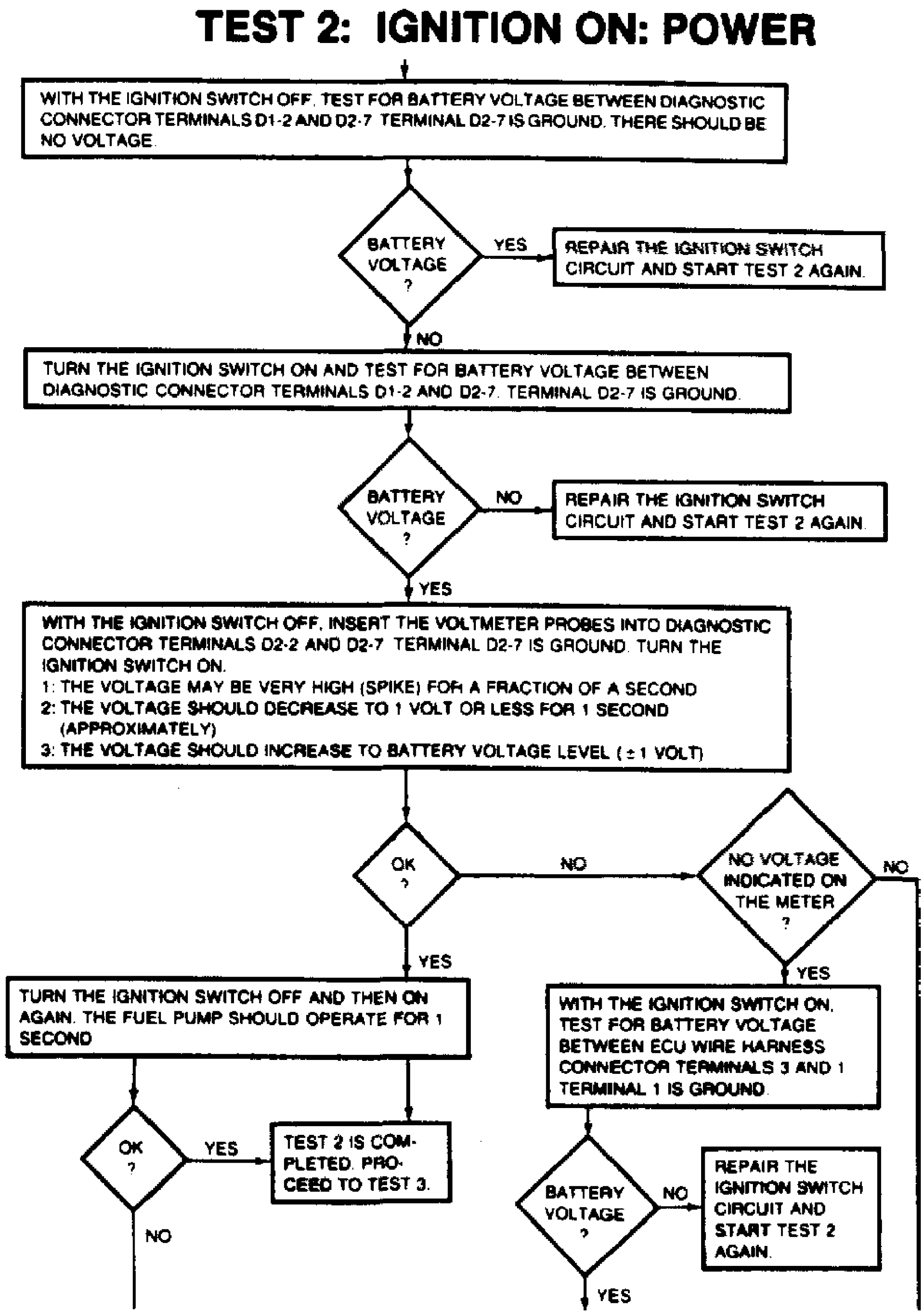


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Fig. 9: TEST 2: IGNITION ON: POWER

CONTINUED FROM PREVIOUS GRAPHIC

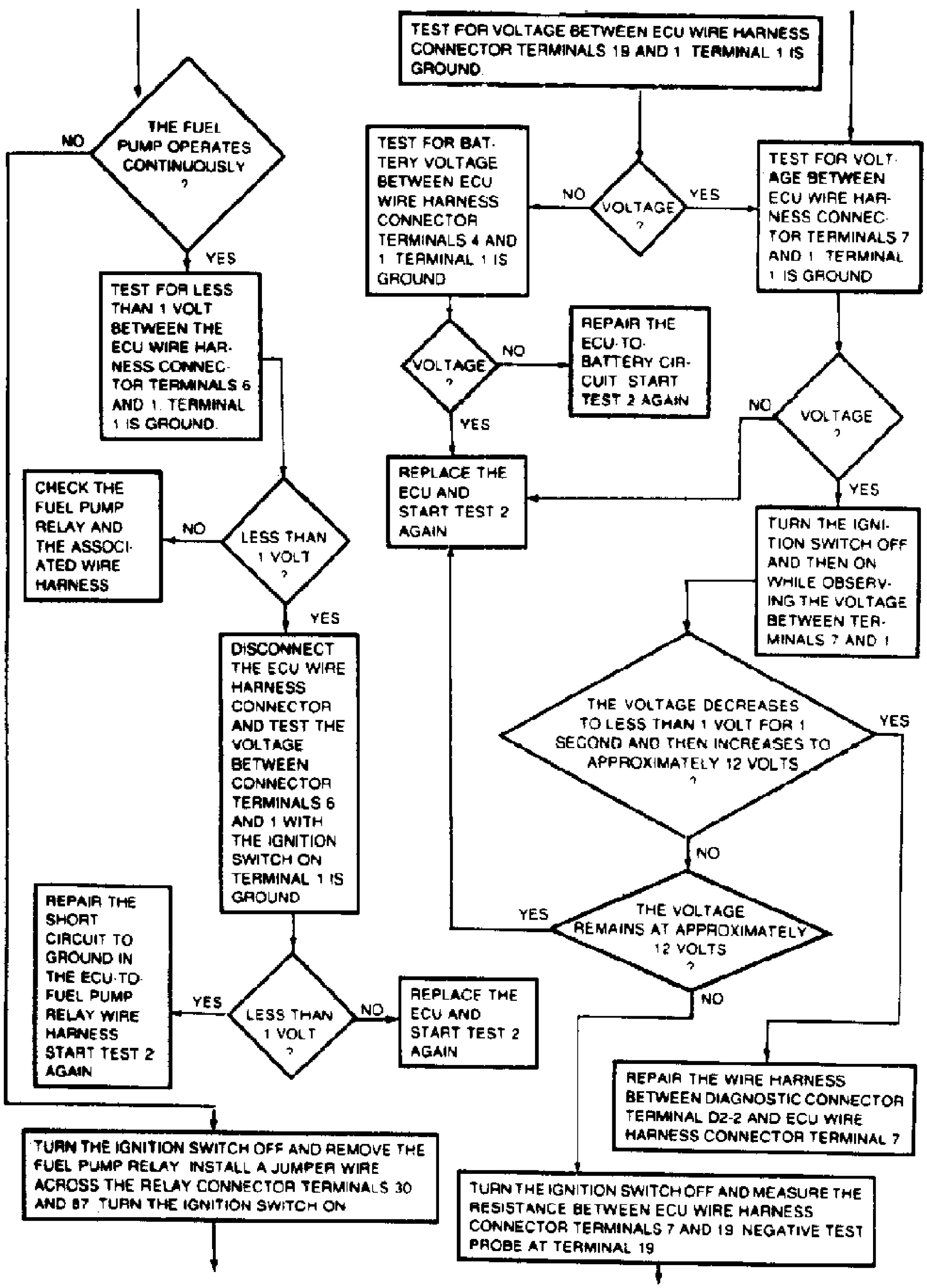

Fig. 10: TEST 2: IGNITION ON: POWER (Cont.)

TEST 3: IGNITION ON: INPUT

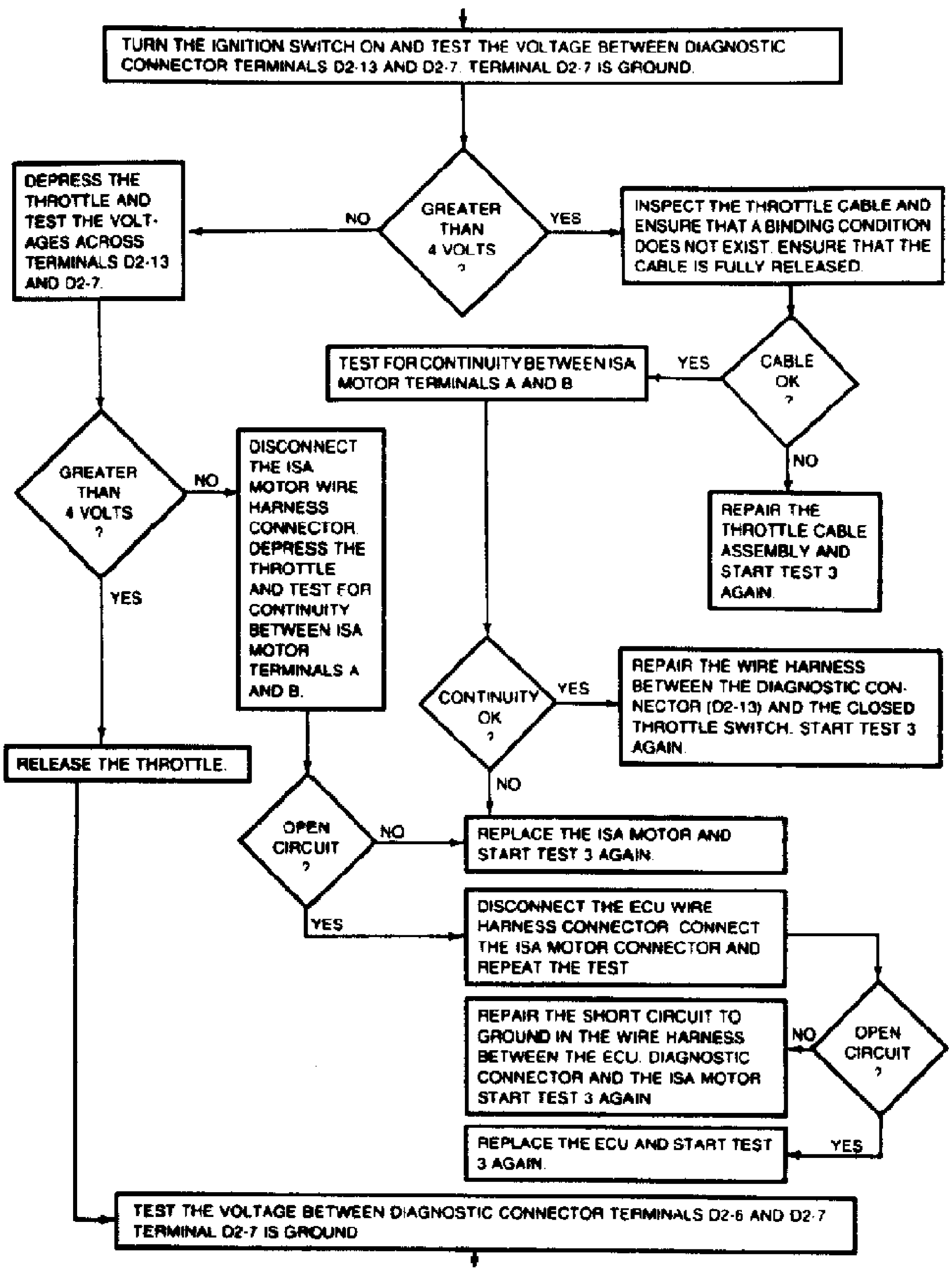

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Fig. 11: TEST 3: IGNITION ON: INPUT

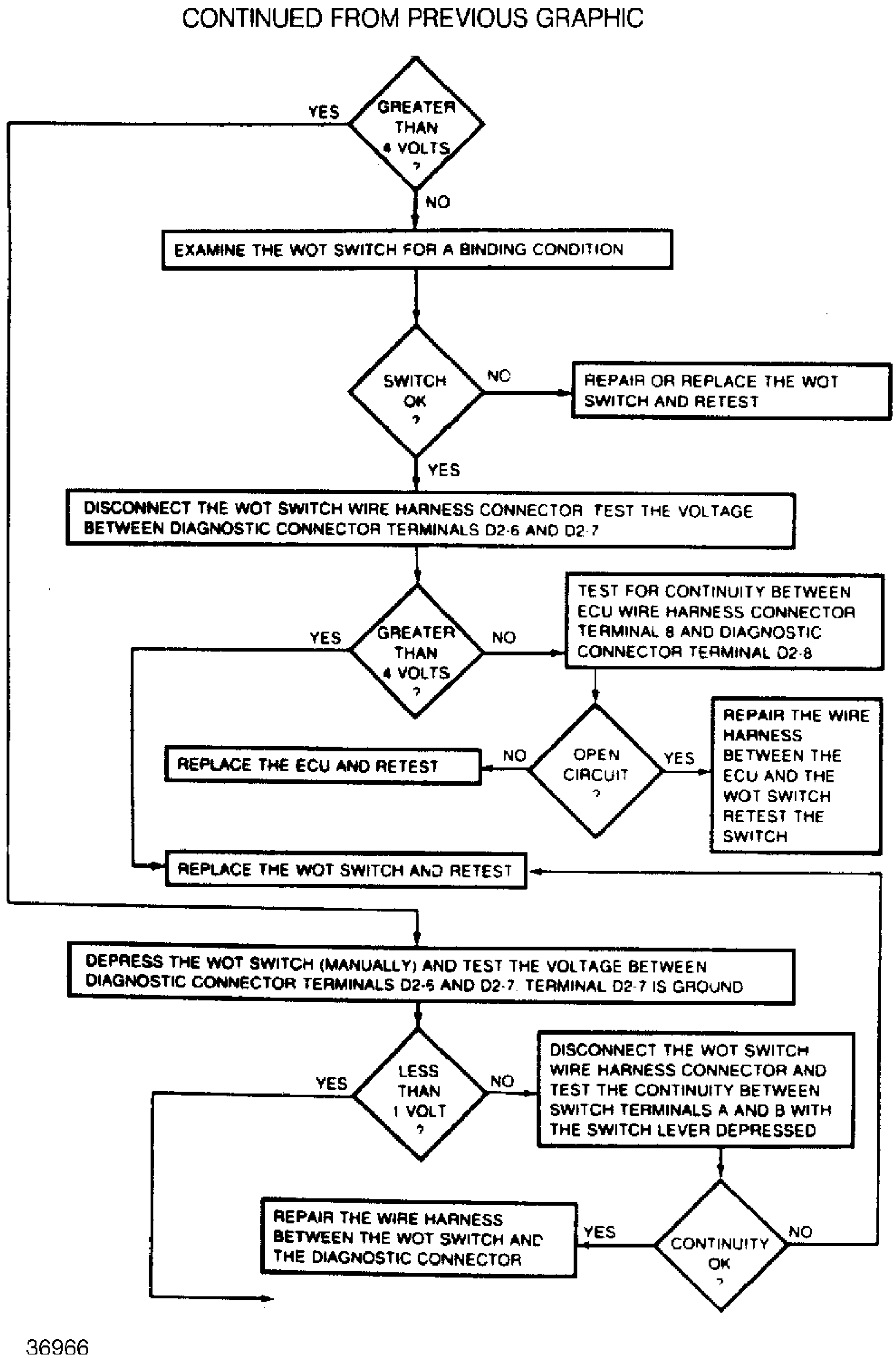

Fig. 12: TEST 3: IGNITION ON: INPUT (Cont.)

TEST 3: IGNITION ON: INPUT (Cont.)

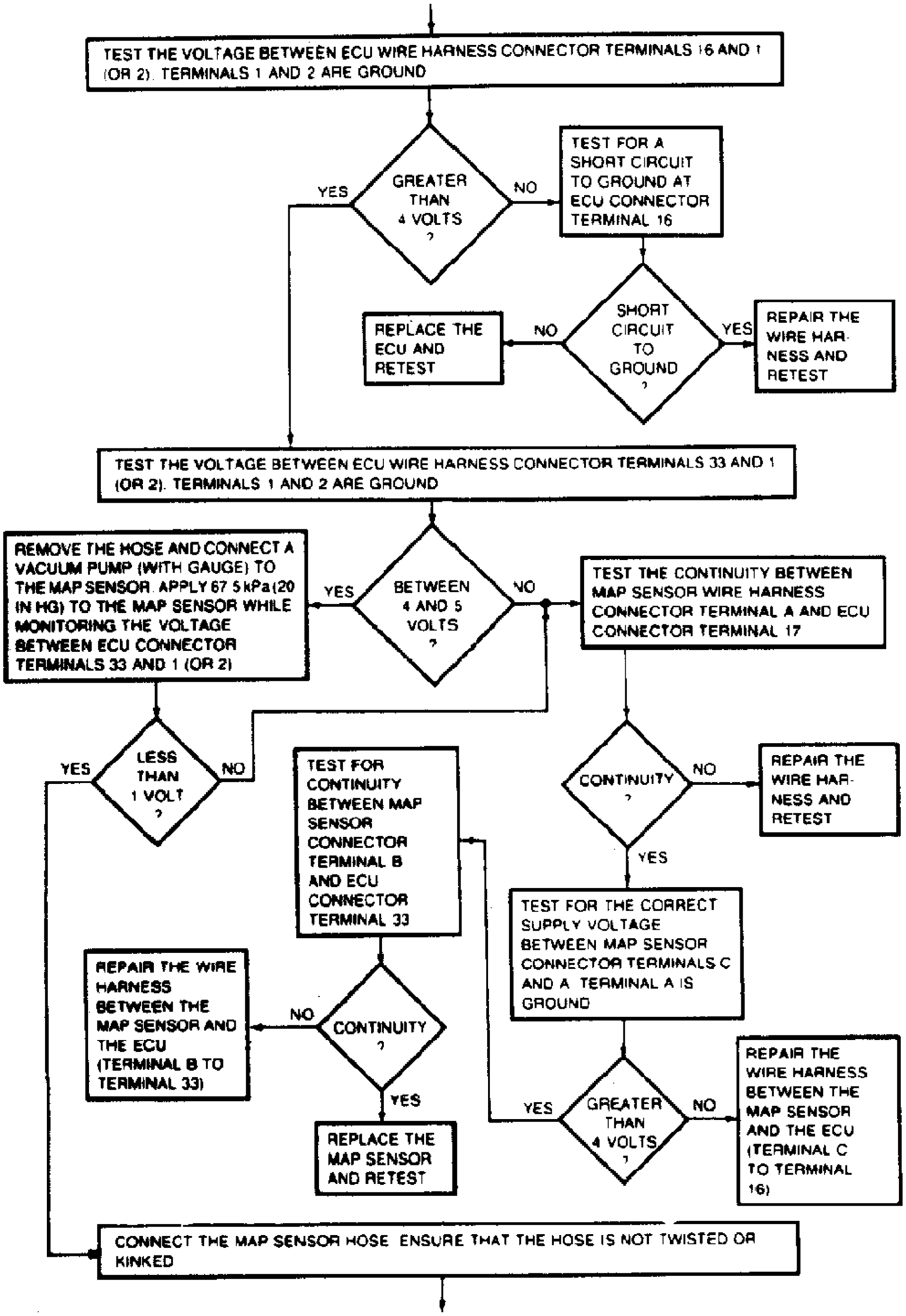

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Fig. 13: TEST 3: IGNITION ON: INPUT (Cont.)

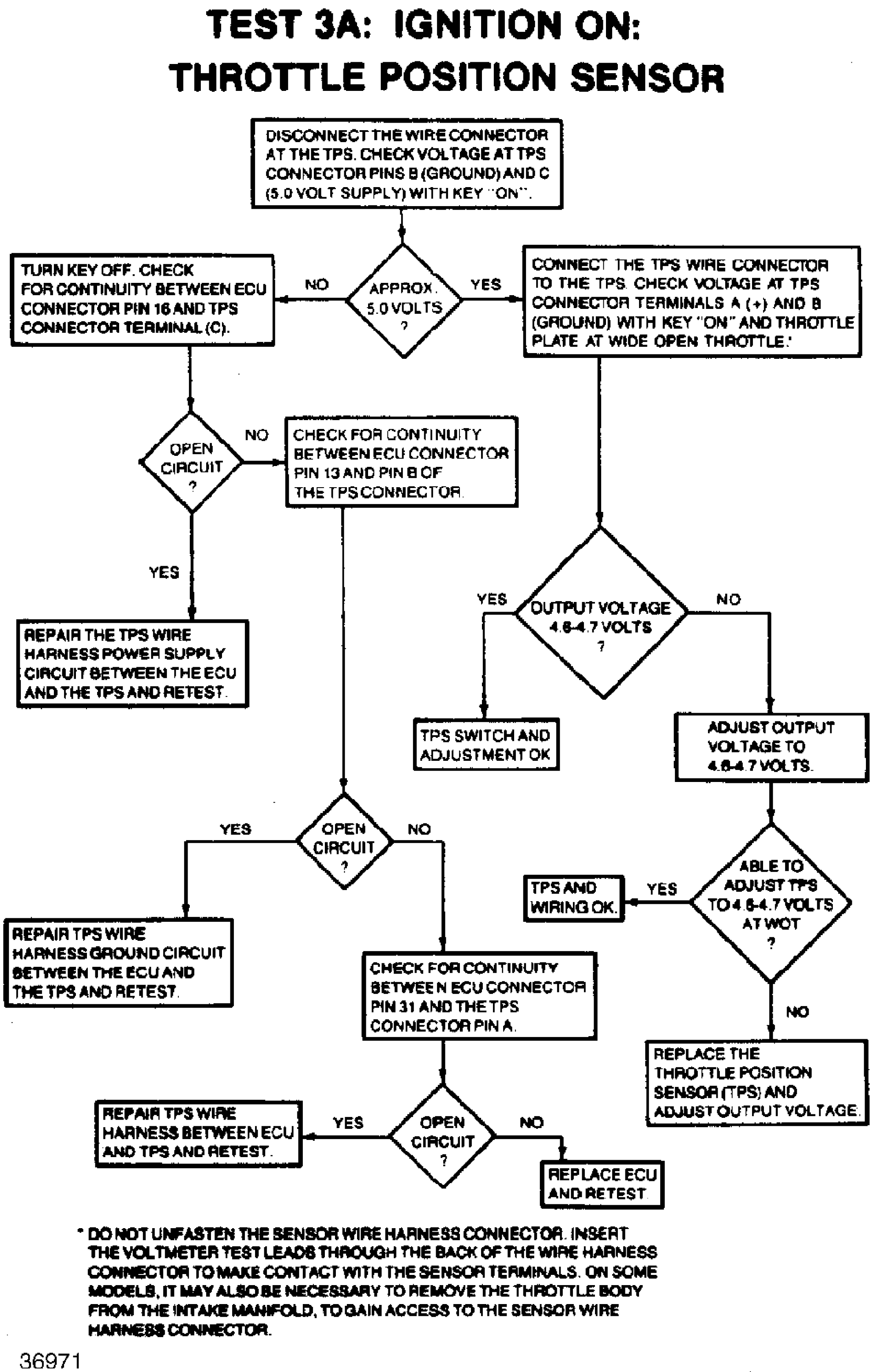

Fig. 14: TEST 3A: IGNITION ON: THROTTLE POSITION SENSOR (M/T)

TEST 4: SYSTEM OPERATIONAL (Cont.)

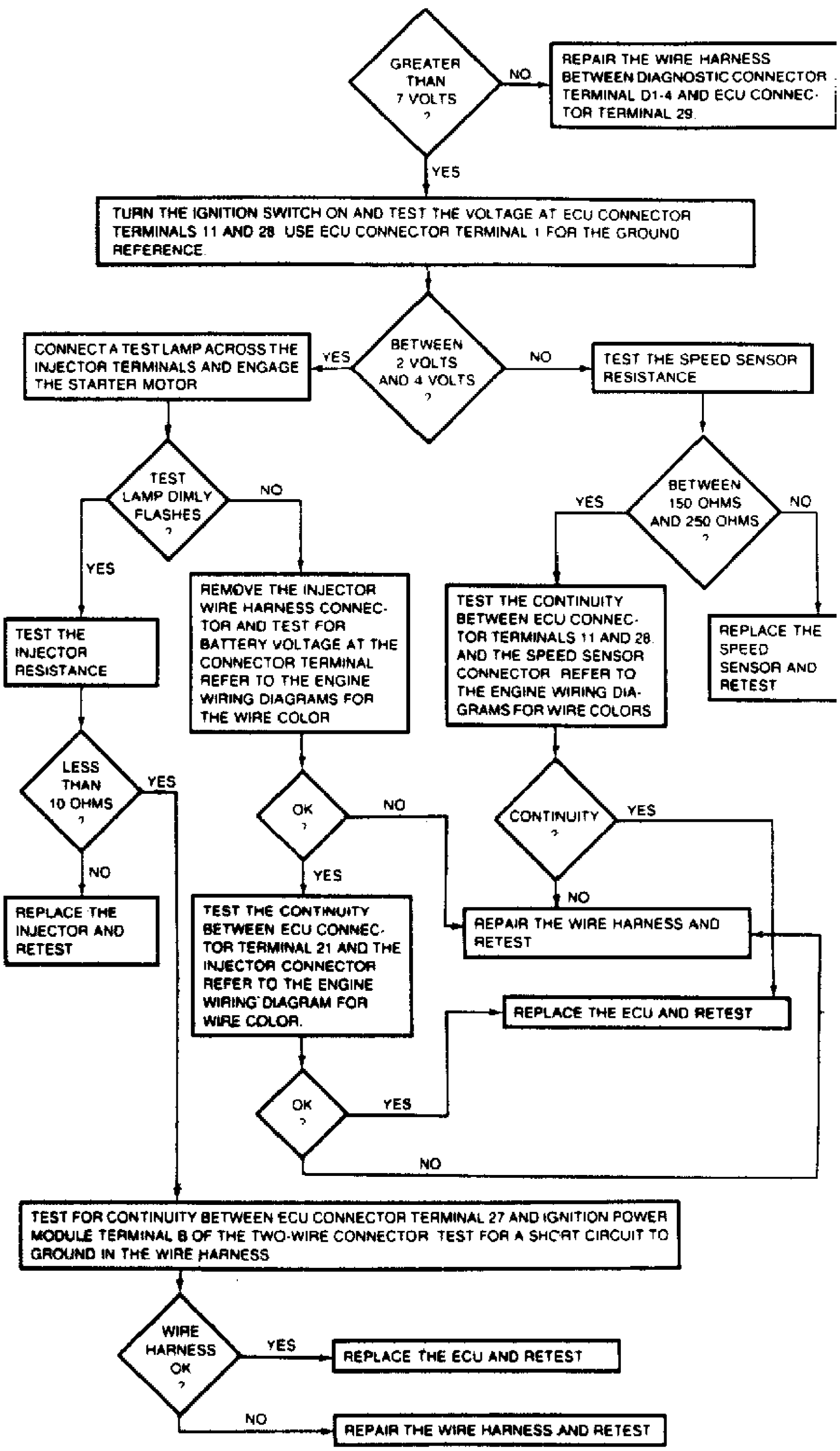

Fig. 15: TEST 4: SYSTEM OPERATIONAL

TEST 4A: SYSTEM OPERATIONAL

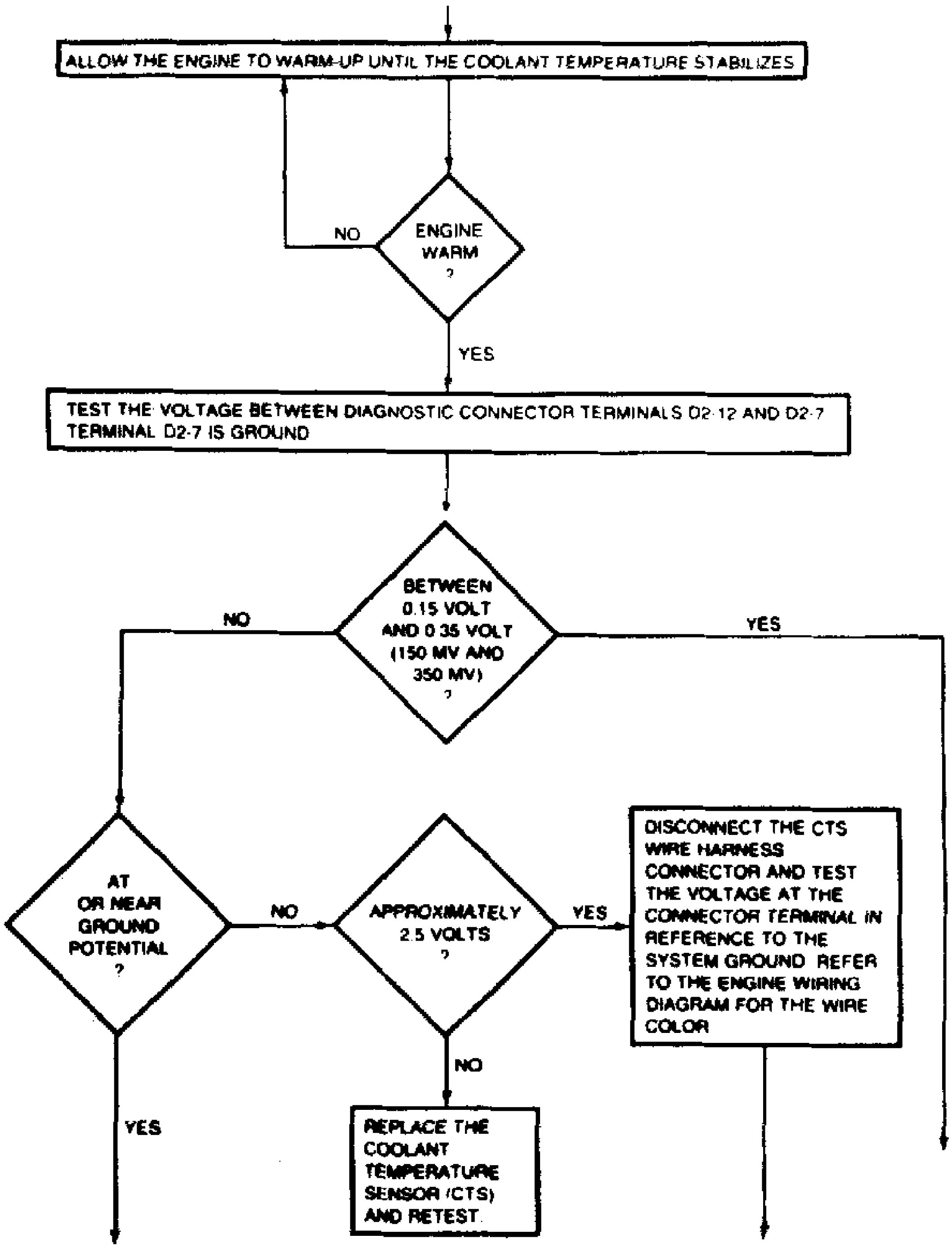

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Fig. 16: TEST 4: SYSTEM OPERATIONAL (Cont.)

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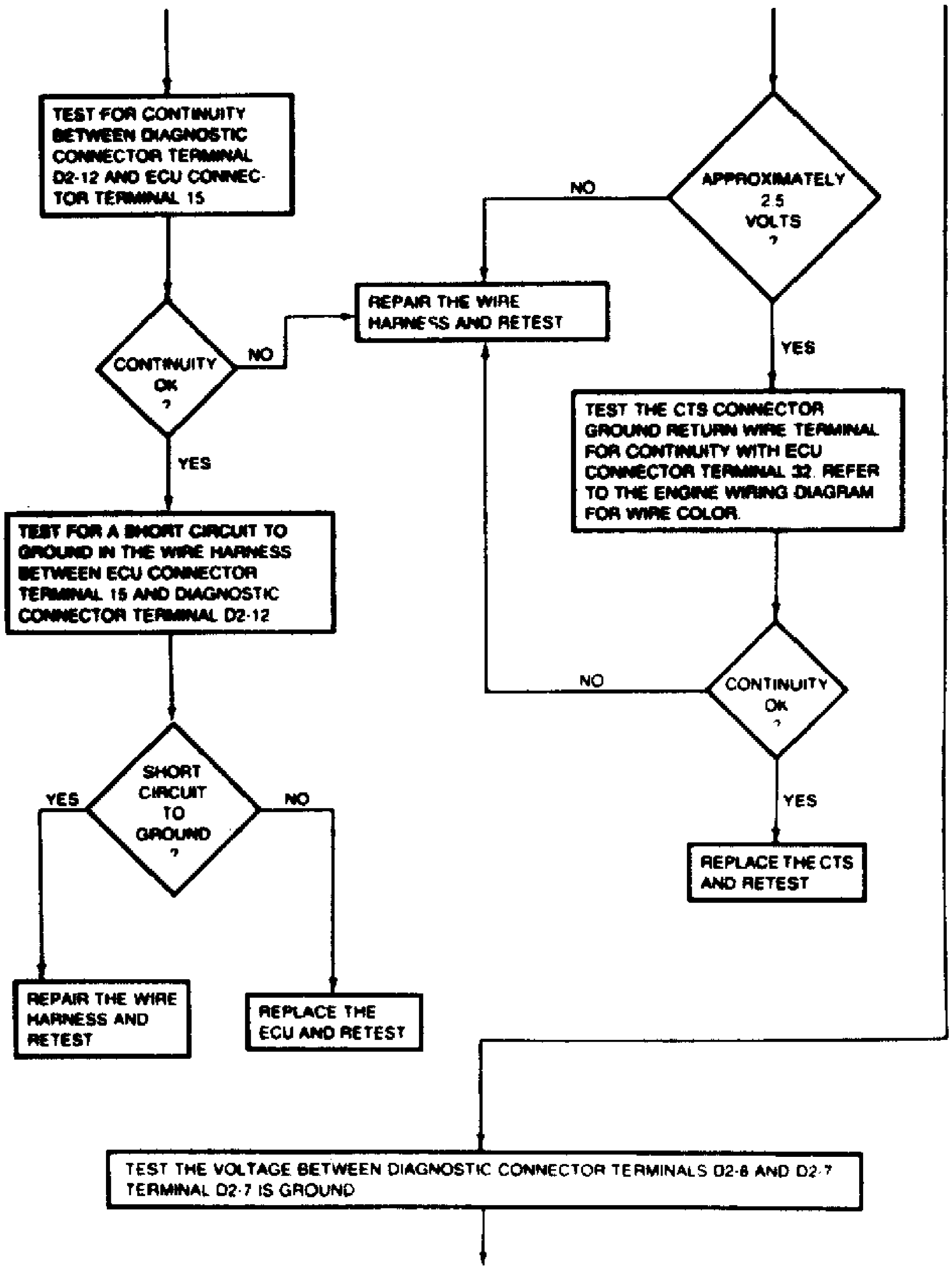

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Fig. 17: TEST 4A: SYSTEM OPERATIONAL

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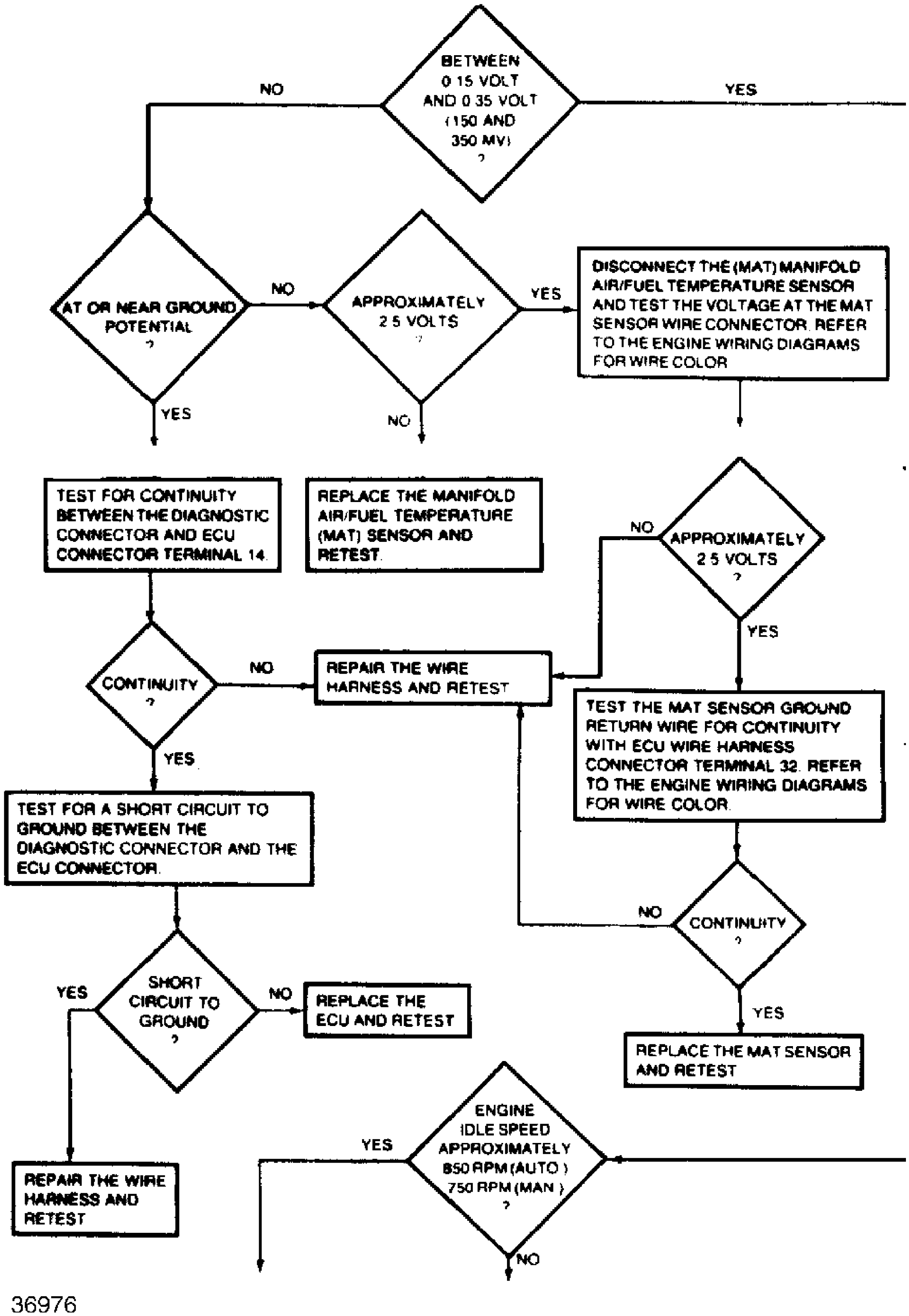

Fig. 18: TEST 4A: SYSTEM OPERATIONAL (Cont.)

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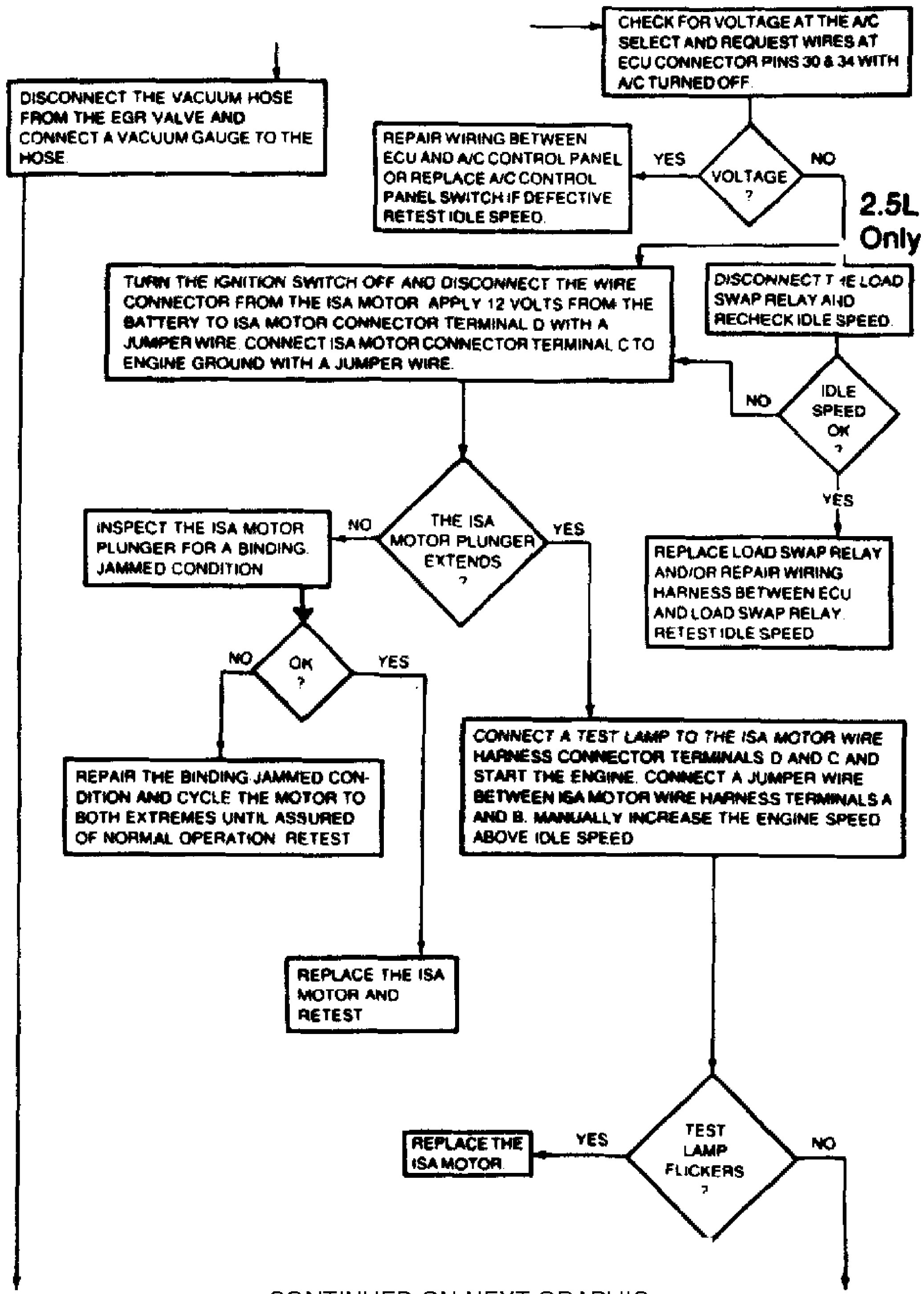

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Fig. 19: TEST 4A: SYSTEM OPERATIONAL (Cont.)

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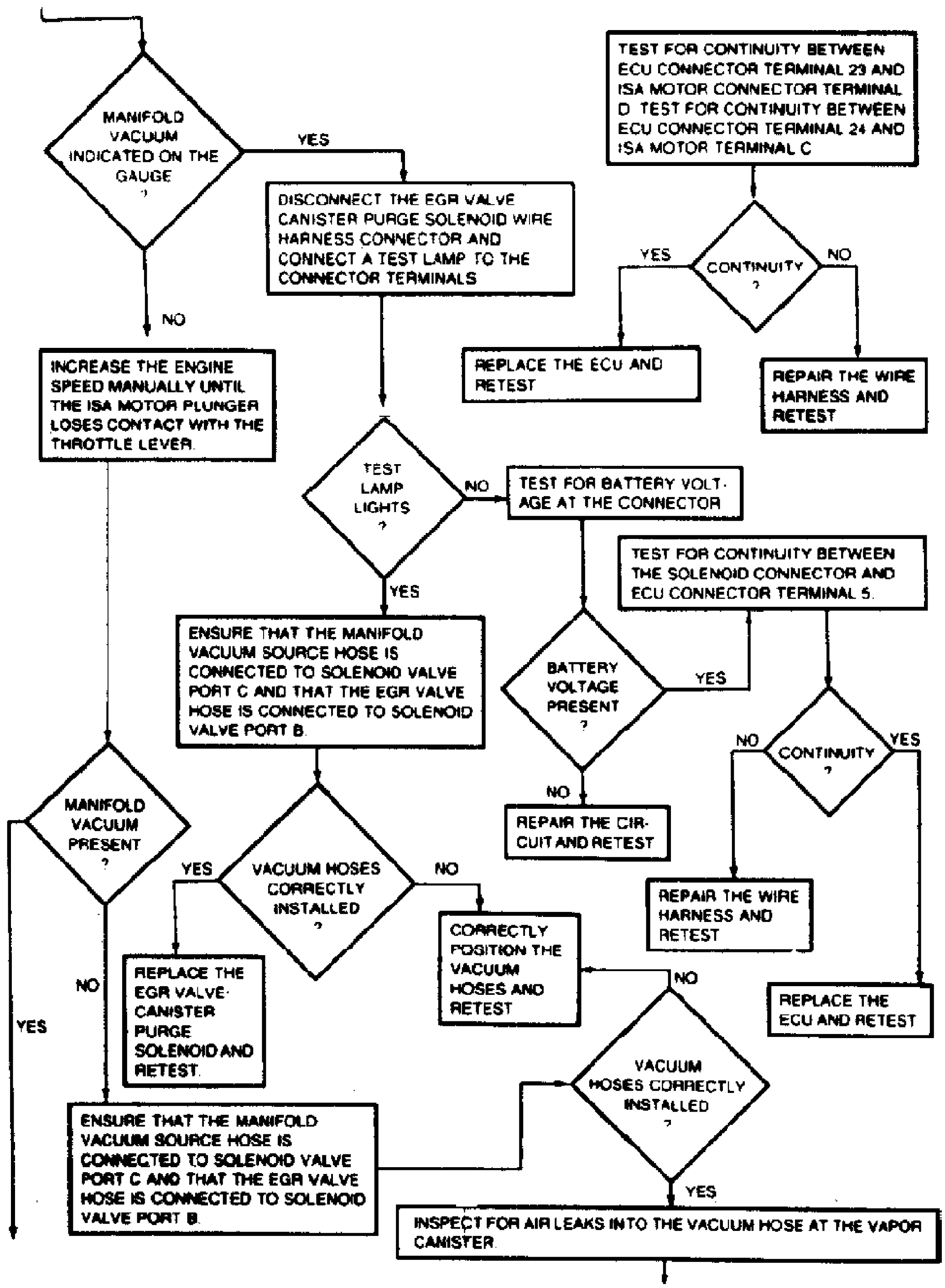

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Fig. 20: TEST 4A: SYSTEM OPERATIONAL (Cont.)

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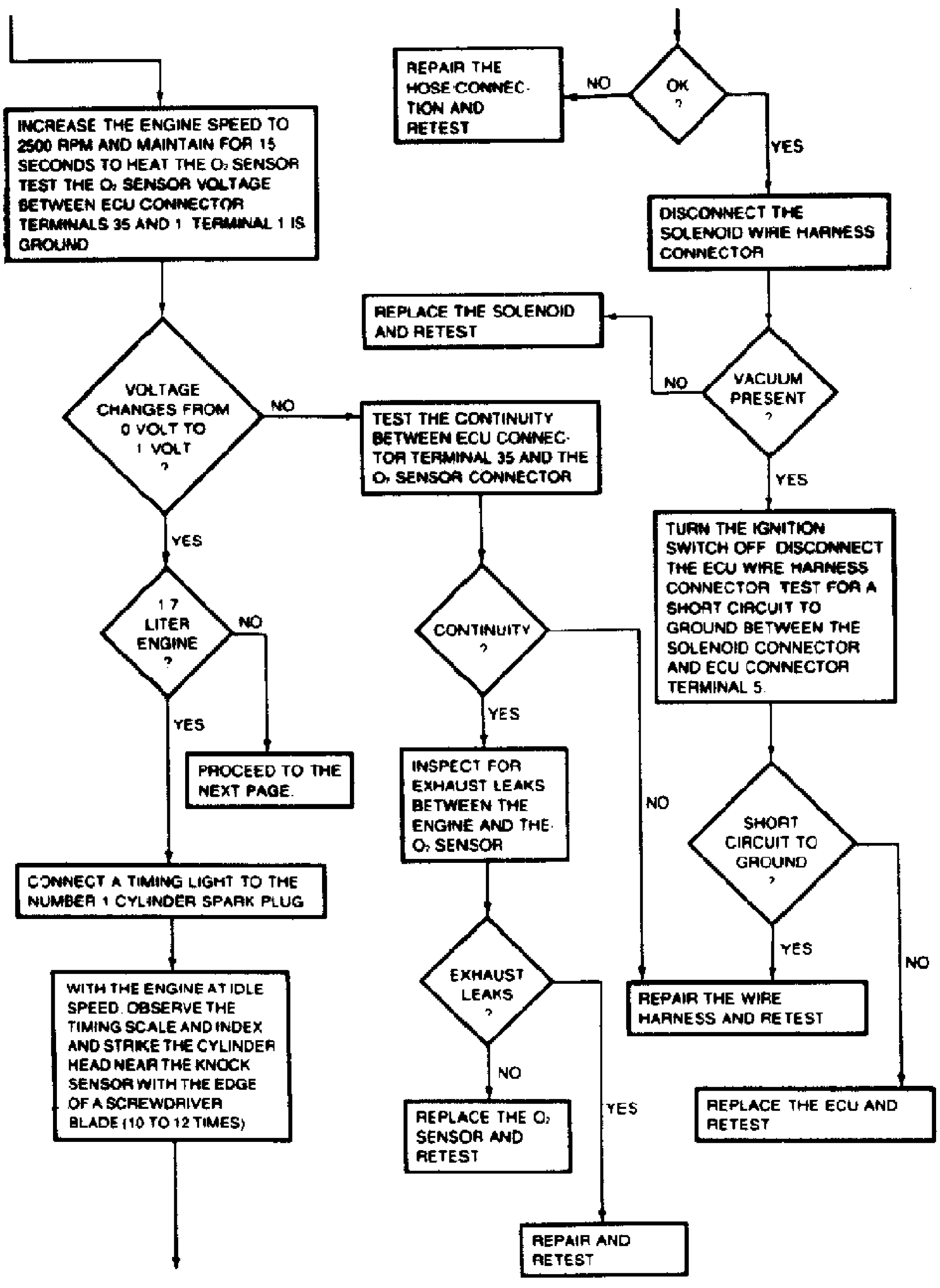

Fig. 21: TEST 4A: SYSTEM OPERATIONAL (Cont.)

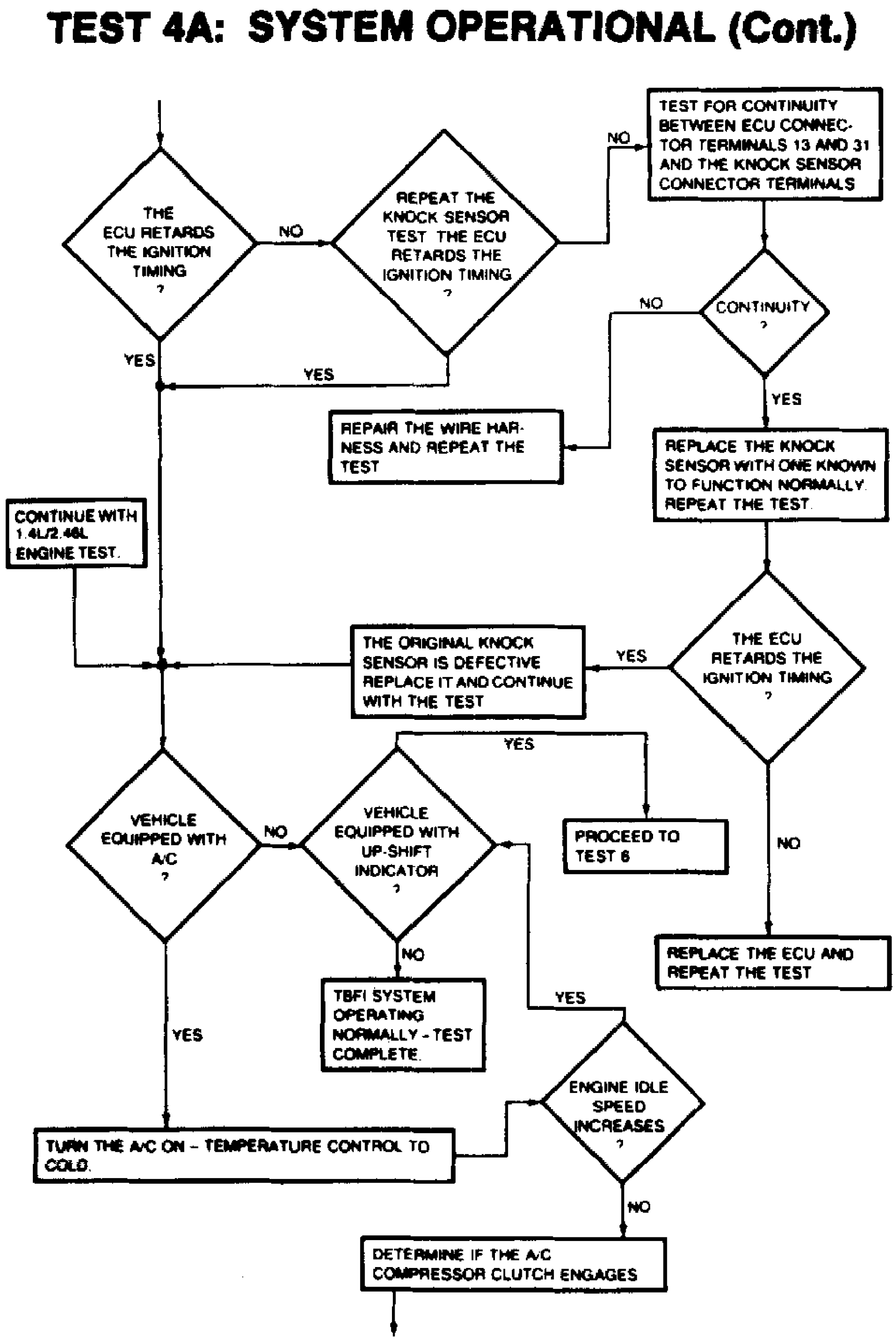

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Fig. 22: TEST 4A: SYSTEM OPERATIONAL (Cont.)

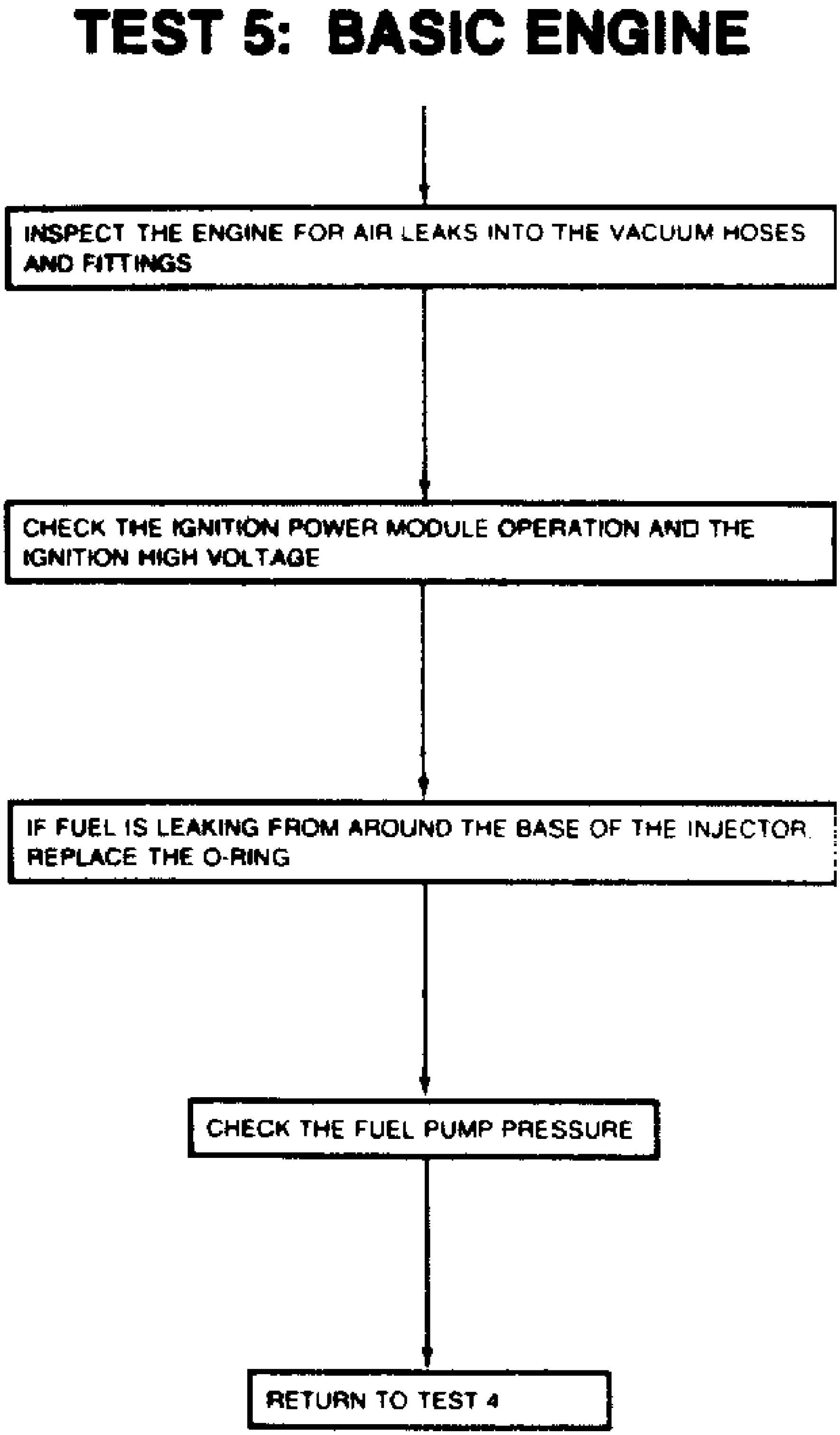

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Fig. 23: TEST 5: BASIC ENGINE

TEST 6: MANUAL TRANSMISSION UP-SHIFT

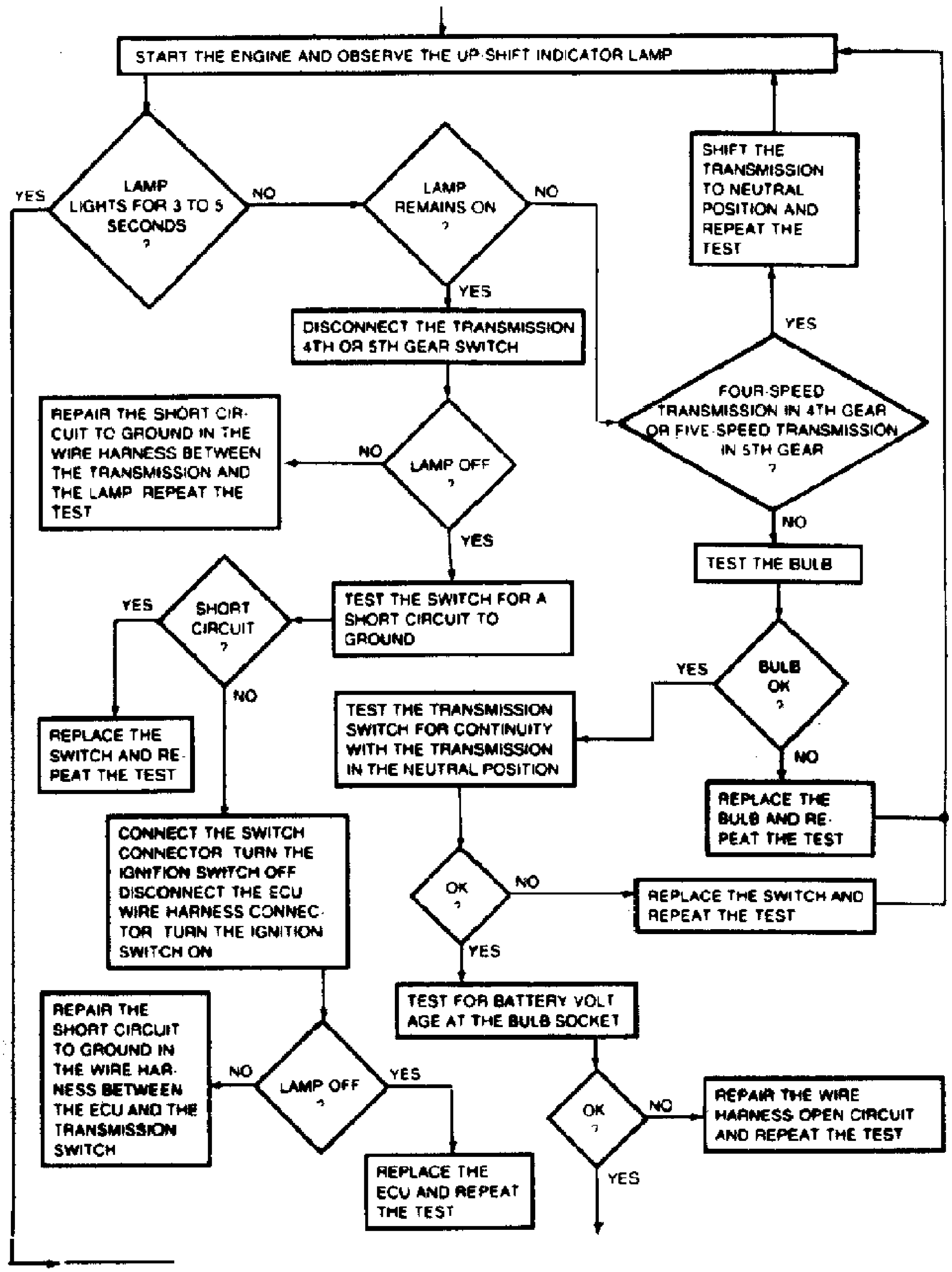

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Fig. 24: TEST 6: MANUAL TRANSMISSION UPSHIFT

WIRING DIAGRAMS

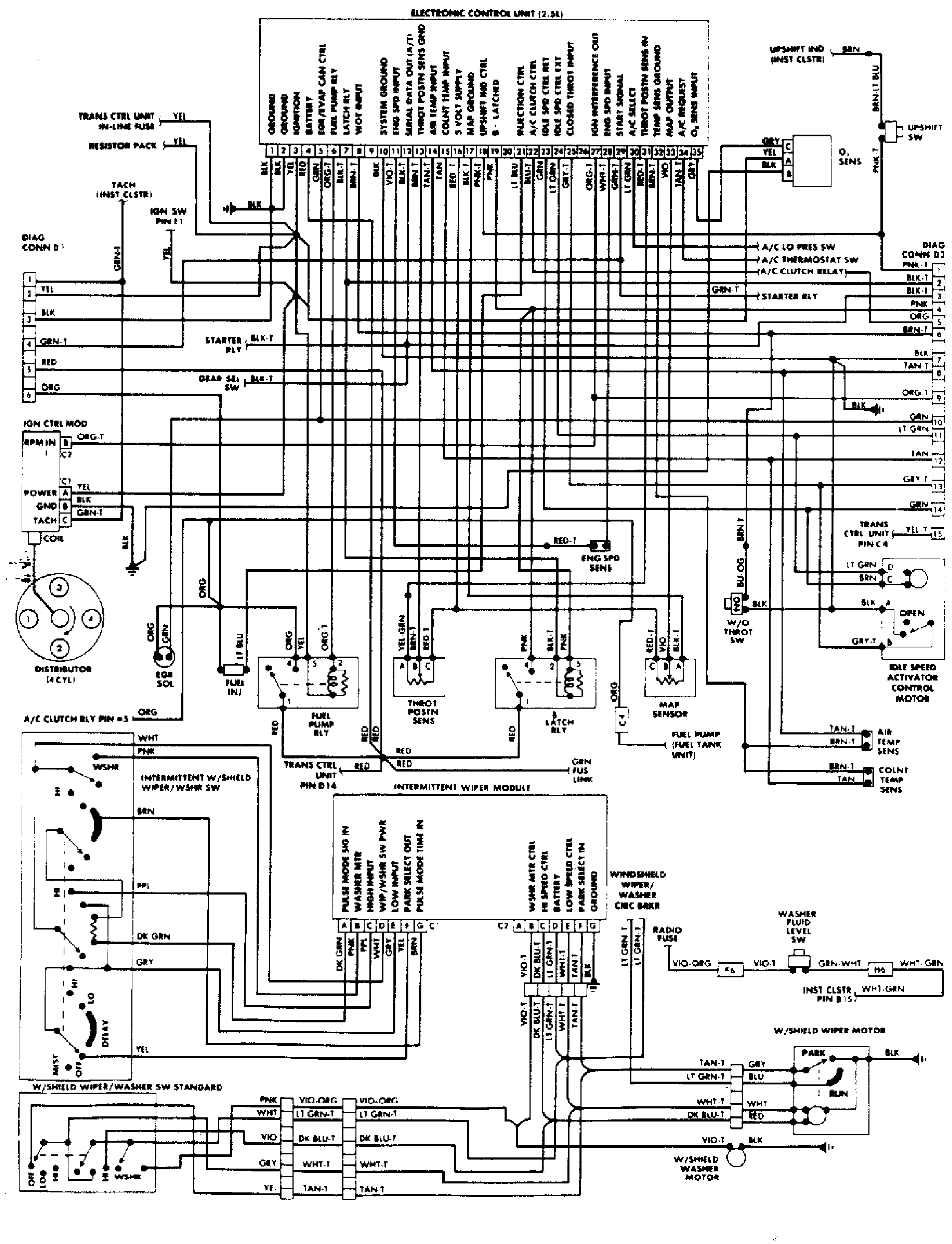

Fig. 25: Cherokee, Comanche & Wagoneer Throttle Body Fuel Injection System Wiring Diagram

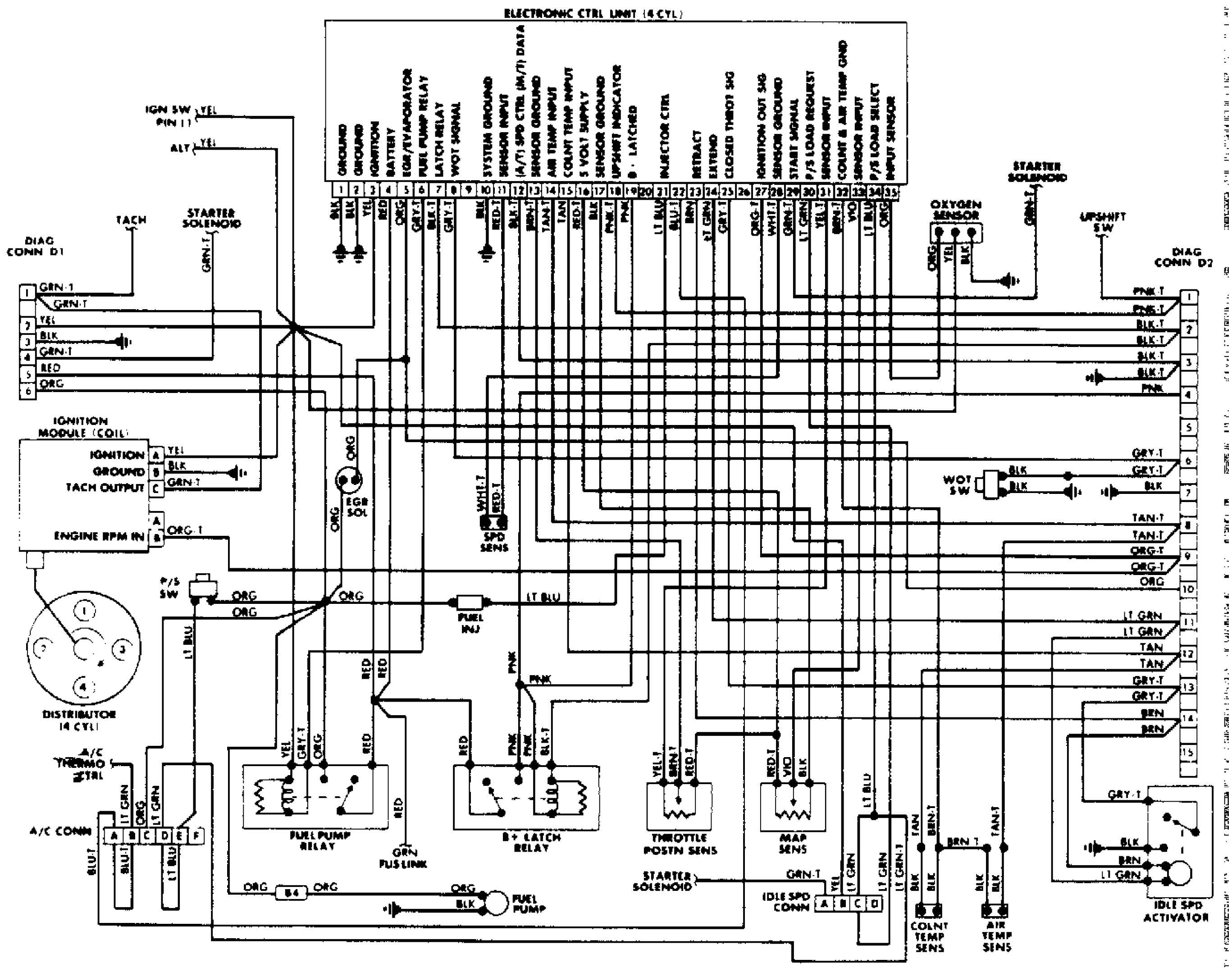

Fig. 26: Wrangler Throttle Body Fuel Injection System Wiring Diagram

FUEL PUMP - ELECTRIC

1988 Jeep Cherokee

1988 Electric Fuel Pump
JEEP

2.5L TBI, 4.0L MPFI

DESCRIPTION & OPERATION

Fuel system on 2.5L TBI models operate under constant fuel pressure of 14.5 psi (1.02 kg/cm²). Fuel pressure regulator is mounted on throttle body assembly. Excess fuel pressure is returned to fuel tank. ECU has no control over fuel pressure relief valve. Fuel pump is immersible type with permanent magnet electric motor.

A frame mounted in-line fuel filter is used. Fuel pump is attached to fuel gauge sending unit in fuel tank. Voltage to operate pump is controlled by Electronic Control Unit (ECU). A ballast resistor is used in the fuel pump control circuit.

Ballast resistor is by-passed during start mode. During running mode, ballast resistor reduces speed of pump by lowering pump voltage. This ensures normal speed in running mode. The 1-ohm ballast resistor is mounted on right side of plenum chamber.

Fuel pump control relay is located on front of right strut tower. Battery voltage is supplied to relay from ignition switch. Relay is energized when ECU provides a circuit to ground.

A multi-cell, roller type pump is used on all 4.0L MPFI models. Pump and fuel filter are located on a plate, forward of rear axle. Fuel pump control relay location for 4.0L models is on right inner front fenderwell. Battery voltage is supplied to relay from ignition switch. Relay is energized when ECU provides a circuit to ground.

Pump contains 2 check valves. One valve relieves internal pump pressure and regulates maximum pump output. Second valve, located near pump outlet, restricts fuel movement in either direction when pump is not in operation. System operates under a constant fuel pressure of 31 psi (2.17 kg/cm²).

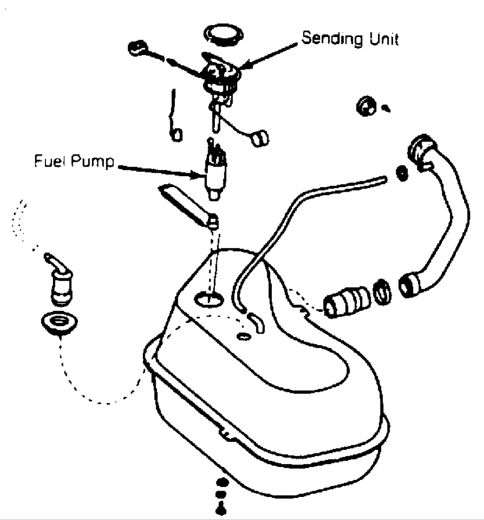

Fig. 1: 2.5L Fuel Pump & Fuel Gauge Sending Unit
Courtesy of Chrysler Motors.

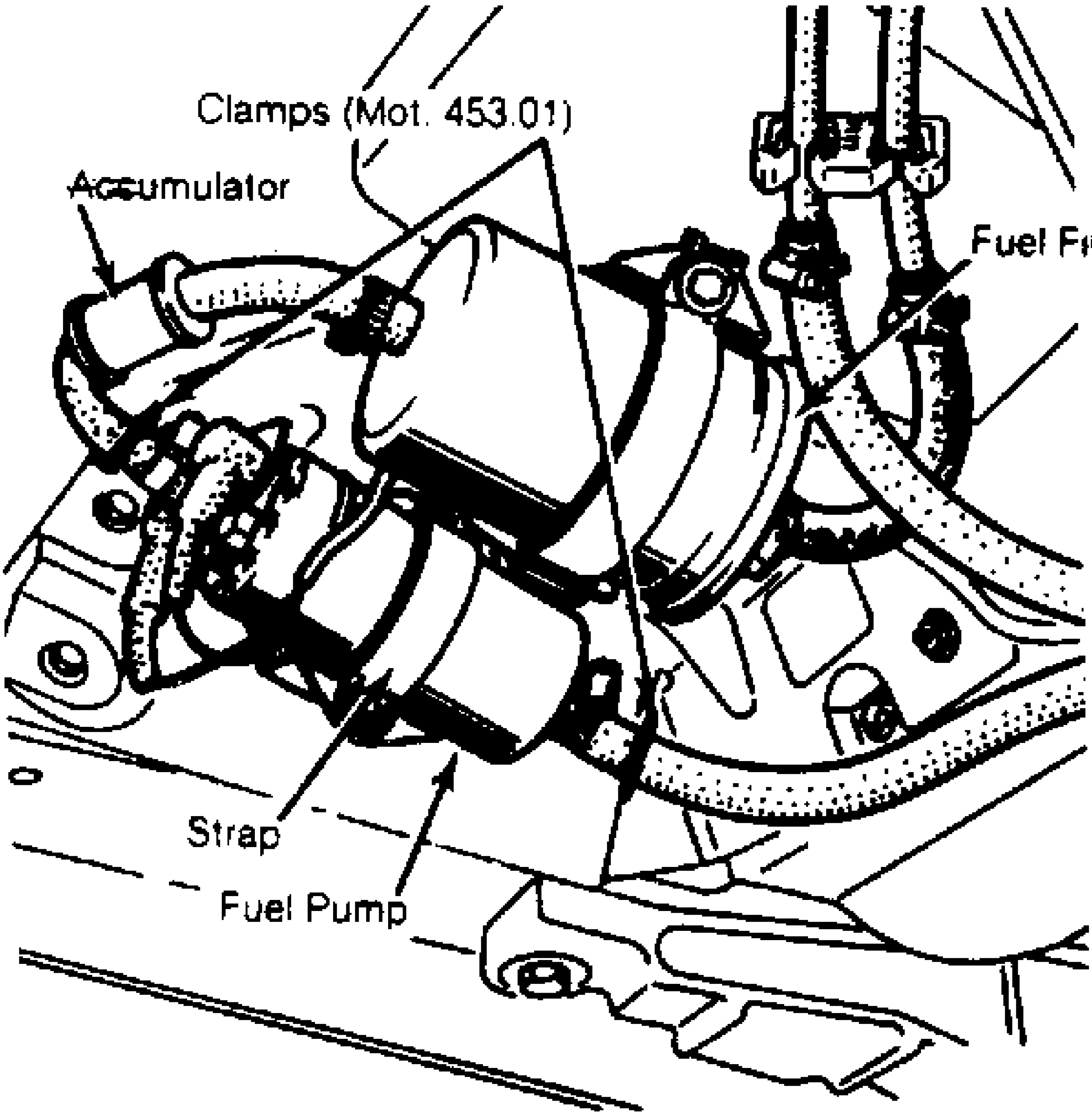

Fig. 2: 4.0L Fuel Pump, Filter & Accumulator
Courtesy of Chrysler Motors

TESTING & DIAGNOSIS

FUEL PUMP PRESSURE TEST

2.5L TBI

1) Adjustment of fuel pressure is required after replacement of pressure regulator. Remove air inlet from throttle body. Connect tachometer to diagnostic connector terminals D1-1 and D1-3. Connect fuel pressure gauge to fuel body pressure test fitting.

NOTE: Some TBI models do not have a pressure test fitting on throttle body. Use Fitting (PN 8983 501 572) for this purpose.

2) Start engine and accelerate to 2000 RPM. Turn adjustment screw to obtain 14.5 psi (1.02 kg/cm^2) fuel pressure. Location of adjustment screw is on bottom of regulator. Install lead seal ball to cover regulator adjustment screw after adjusting fuel pressure to specification. Turn ignition off. Disconnect fuel pressure gauge. Install cap on test fitting. Install air inlet.

NOTE: To increase fuel pressure, turn adjustment screw inward. To decrease fuel pressure, turn adjustment screw outward.

4.0L MPFI

1) Remove cap from pressure test port in fuel rail. Connect Fuel Pressure Gauge (J-37730-1) to pressure fitting. Start vehicle. Pressure should be approximately 31 psi (2.7 kg/cm^2) with vacuum hose connected to pressure regulator.

2) Pressure should be 39 psi (2.74 kg/cm^2) with vacuum hose removed from regulator. If fuel pressure is not to specifications, check for kinks or restricting bends in fuel supply and return lines. Check fuel pump flow rate. Pump should deliver minimum of 1.06 quarts (one liter) of fuel per minute with fuel return line pinched off.

3) If flow is inadequate, check system for plugged fuel filter or filter sock. Fuel pump flow rate can be checked by connecting a hose to fuel test port on fuel rail and inserting other end in clean container.

4) To operate fuel pump, install a jumper wire into diagnostic connector terminals D1-5 and D1-6. Pinch off fuel return line to ensure that no fuel returns to fuel tank. If fuel pressure is still not to specifications and fuel flow is normal, replace regulator.

REMOVAL & INSTALLATION

FUEL PUMP

Removal (2.5L TBI)

1) Disconnect battery cables. Ensure fuel level is less than 1/2 for this procedure. Remove fuel outlet and return hoses. Remove sending unit wires. Remove sending unit retaining lock ring.

2) Remove sending unit/pump assembly with "O" ring seal. Disconnect fuel hose from fuel pump. Disconnect wires from fuel pump. Remove fuel pump from sending unit.

Installation

Clean seal contact are of fuel tank. Install new "O" ring seal. Install a new filter on end of suction tube. Position sending unit/pump assembly in tank. To complete installation, reverse removal procedure. Start engine and check for leaks.

CAUTION: Fuel leaks can develop from over tightening sending unit/pump during installation.

Removal (4.0L MPFI)

Install clamps (MOT. 453.01) on fuel pump inlet and outlet hoses. Disconnect hoses from fuel pump. Disconnect electrical connectors. Remove retaining strap. Remove fuel pump.

Installation

To install, reverse removal procedure. Ensure that clamps (MOT. 453.01) have been removed from fuel lines. Start engine and check for leaks.

NOTE: Accumulator is located between fuel pump and fuel filter on 4.0L models.

FUSES & CIRCUIT BREAKERS

1988 Jeep Cherokee

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Fuses & Circuit Breakers
1984-88 AMC/Jeep

Jeep;  Cherokee, Wagoneer
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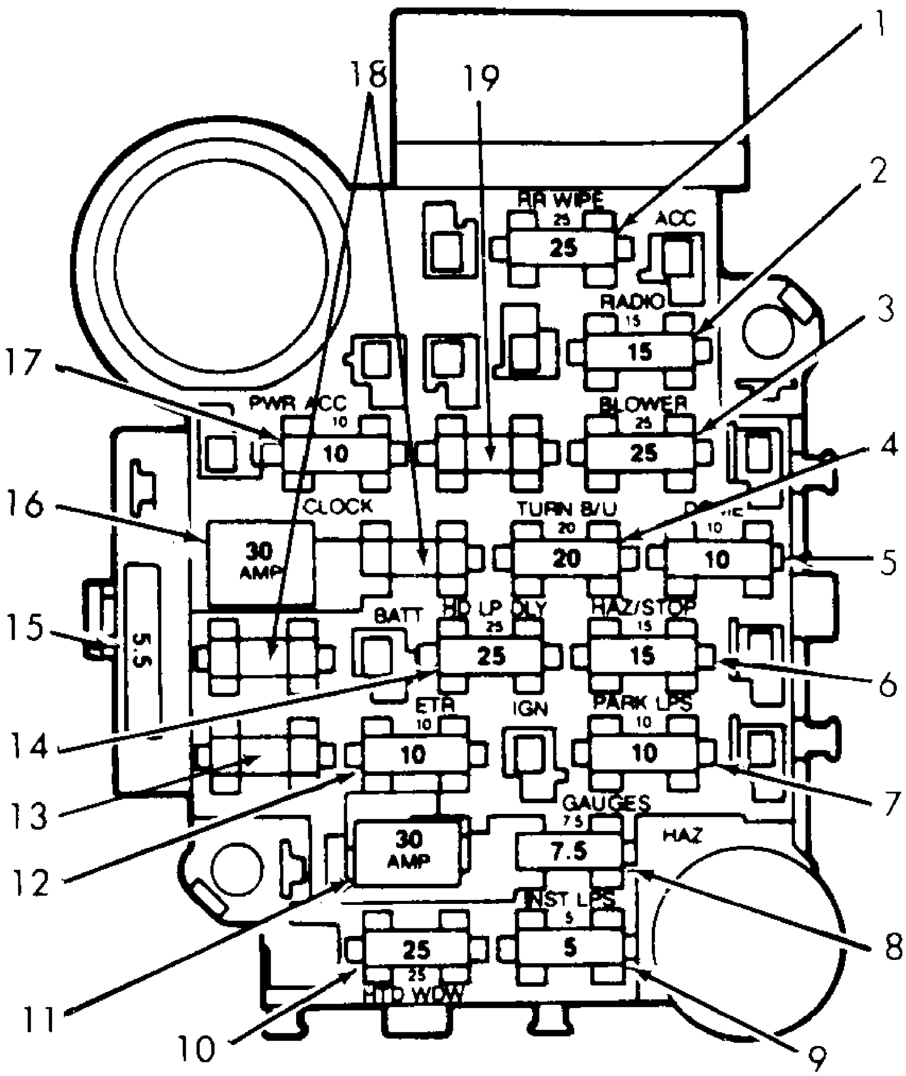
IDENTIFICATION

FUSES & CIRCUIT BREAKERS

Fuse panel is located at the lower left side of dash on most models.



93C44570

Fig. 1: Fuse Panel Identification
Courtesy of American Motors Corp.

FUSE & CIRCUIT BREAKER IDENTIFICATION

1 - 25 Amp
Rear Washer/Wiper.

2 - 15 Amp
Radio, Cigarette Lighter.

3 - 25 Amp
Blower Motor.

4 - 20 Amp
Turn Signal, Back-Up Lights, Rear Window Defogger Relay.

5 - 10 Amp
Dome Light, Courtesy Lights, Glove Box Light, Cargo Light, Radio Memory, Power Mirrors, Teltak Connector.

6 - 15 Amp
Hazard Warning System, Stoplights.

7 - 10 Amp
Parking Lights, Headlight Warning Chime/Buzzer, Instrument Panel Light Dimmer.

8 - 7.5 Amp
Gauges, Instrument Cluster, Seat Belt Warning, Headlight Delay, Chime Module, Overhead Console.

9 - 5 Amp
Instrument Panel Illumination.

10 - 25 Amp
Rear Window Defogger.

11 - 30 Amp (Circuit Breaker)
Power Door Locks, Power Seats, Trailer Towing Wiring Harness.

12 - 10 Amp
ETR Radio, Power Antenna.

13 - Not Used (1984-87); 7.5 Amp (1988)
Transmission Control Unit.

14 - 25 Amp
Headlight Delay, Horns, Security Alarm.

15 - 5.5 Amp (Circuit Breaker)
Front Wiper.

16 - 30 Amp (Circuit Breaker)
Power Windows.

17 - 10 Amp
Clock, Security Alarm (Ign).

CAUTIONS & WARNINGS

REPLACING BLOWN FUSES

Before replacing a blown fuse, remove ignition key, turn off all lights and accessories to avoid damaging the electrical system. Be sure to use fuse with the correct indicated amperage rating. The use of an incorrect amperage rating fuse may result in a dangerous

electrical system overload.

BATTERY WARNING

WARNING: When battery is disconnected, vehicles equipped with computers may lose memory data. When battery power is restored, driveability problems may exist on some vehicles. These vehicles may require a relearn procedure. See the COMPUTER RELEARN PROCEDURES article in GENERAL INFORMATION section.

ELECTROSTATIC DISCHARGE SENSITIVE (ESD) PARTS

WARNING: Many solid state electrical components can be damaged by static electricity (ESD). Some will display a warning label, but many will not. Discharge personal static electricity by touching a metal ground point on the vehicle prior to servicing any ESD sensitive component.

HALOGEN BULBS

Halogen bulbs contain pressurized gas which may explode if overheated. DO NOT touch glass portion of bulb with bare hands. Eye protection should be worn when handling or working around halogen bulbs.

RADIATOR CAP

CAUTION: Always disconnect the fan motor when working near the radiator fan. The fan is temperature controlled and could start at any time even when the ignition key is in the OFF position. DO NOT loosen or remove radiator cap when cooling system is hot.

GEAR TOOTH CONTACT PATTERNS

1988 Jeep Cherokee

GENERAL INFORMATION
Gear Tooth Contact Patterns

* PLEASE READ THIS FIRST *

The following article is for GENERAL INFORMATION purposes only. Information does not SPECIFICALLY apply to all years, makes and models, but is to be used as a general reference guide.

INSPECTION

PRELIMINARY INSPECTION

Wipe lubricant from internal parts. Rotate gears and inspect for wear or damage. Mount dial indicator to housing, and check backlash at several points around ring gear. Backlash must be within specifications at all points. If no defects are found, check gear tooth contact pattern.

GEAR TOOTH CONTACT PATTERN

NOTE: Drive pattern should be well centered on ring gear teeth. Coast pattern should be centered, but may be slightly toward toe of ring gear teeth.

1) Paint ring gear teeth with marking compound. Wrap cloth or rope around drive pinion flange to act as brake. Rotate ring gear until clear tooth contact pattern is obtained.

2) Contact pattern will indicate whether correct pinion bearing mounting shim has been installed and if drive gear backlash has been set properly. Backlash between drive gear and pinion must be maintained within specified limits, until correct tooth pattern is obtained.

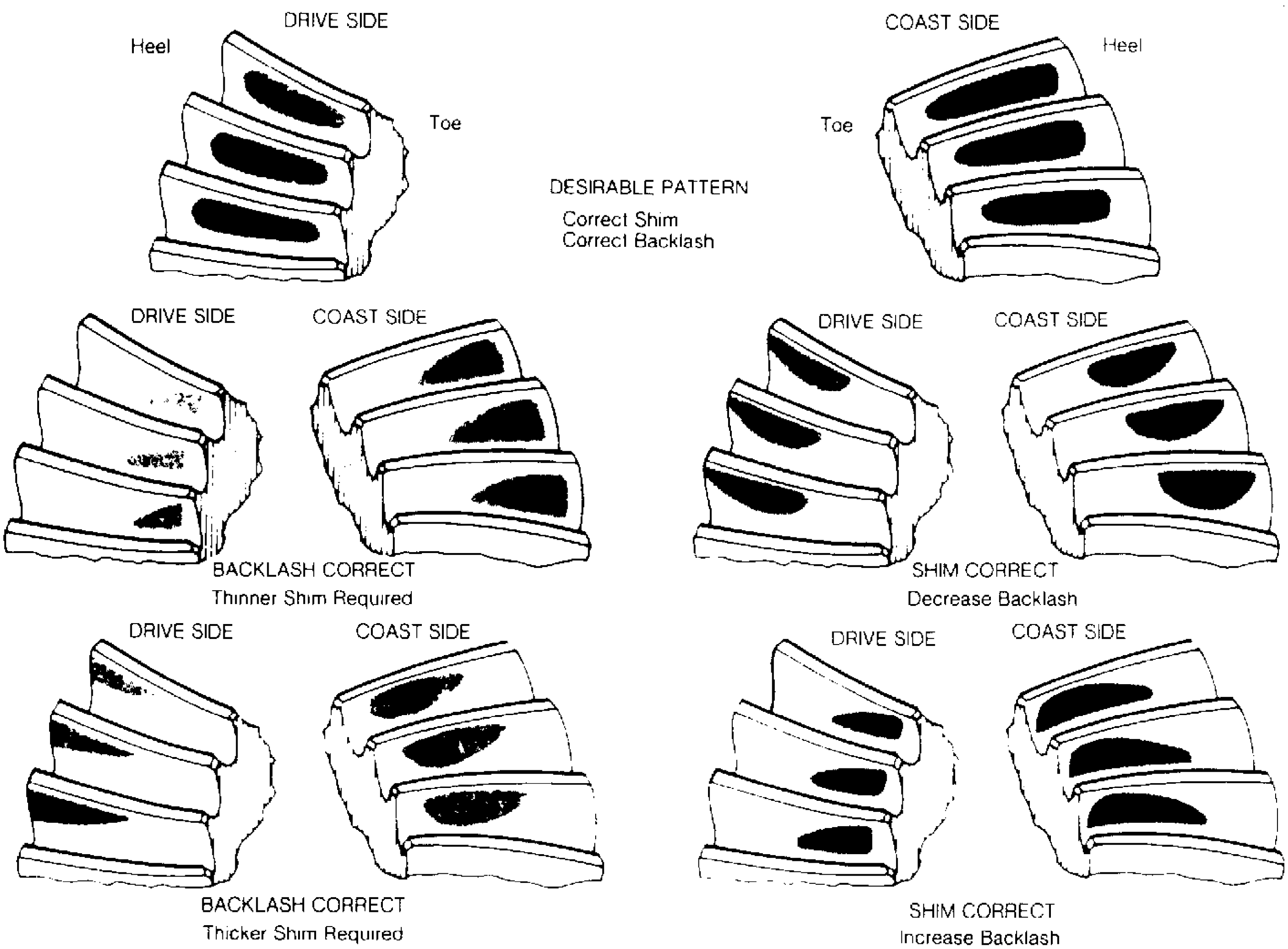


Fig. 1: Drive Axle Gear Tooth Patterns

ADJUSTMENTS

GEAR BACKLASH & PINION SHIM CHANGES

NOTE: Backlash is adjusted by either moving shims from one side of differential case to the other or by turning adjusting nuts on which side bearing races ride. Changing of pinion shims alters the distance from face of pinion of centerline of ring gear.

1) With no change in backlash, moving pinion further from ring gear moves drive pattern toward heel and top of tooth, and moves coast pattern toward toe and top of tooth.

2) With no change in backlash, moving pinion closer to ring gear moves drive pattern toward toe and bottom of tooth, and moves coast pattern toward heel and bottom of tooth.

3) With no change in pinion shim thickness, an increase in backlash moves ring gear further from pinion. Drive pattern moves toward heel and top of tooth, and coast pattern moves toward heel and top of tooth.

4) With no change in pinion shim thickness, decrease in

backlash moves ring gear closer to pinion gear. Drive pattern moves toward toe and bottom of tooth, and coast pattern moves toward toe and bottom of tooth.

GENERAL COOLING SYSTEM SERVICING

1988 Jeep Cherokee

GENERAL INFORMATION
General Cooling System Servicing

* PLEASE READ THIS FIRST *

The following article is for general information only. Information may not apply to all years, makes and models. See specific article in the ENGINE COOLING section.

DESCRIPTION

The basic liquid cooling system consists of a radiator, water pump, thermostat, electric or belt-driven cooling fan, pressure cap, heater, and various connecting hoses and cooling passages in the block and cylinder head.

MAINTENANCE

DRAINING

Remove radiator cap and open heater control valve to maximum heat position. Open drain cocks or remove plugs in bottom of radiator and engine block. In-line engines usually have one plug or drain cock, while "V" type engines will have 2, one in each bank of cylinders.

CLEANING

A good cleaning compound removes most rust and scale. Follow manufacturer's instructions in the use of cleaner. If considerable rust and scale has to be removed, cooling system should be flushed. Clean radiator air passages with compressed air.

FLUSHING

CAUTION: Some manufacturers use an aluminum and plastic radiator. Flushing solution must be compatible with aluminum.

Back Flushing

Back flushing is an effective means of removing cooling system rust and scale. The radiator, engine and heater core should be flushed separately.

Radiator

To flush radiator, connect flushing gun to water outlet of radiator and disconnect water inlet hose. To prevent flooding engine, use a hose connected to radiator inlet. Use air in short bursts to prevent damage to radiator. Continue flushing until water runs clear.

Engine

To flush engine, remove thermostat and replace housing. Connect flushing gun to water outlet of engine. Flush using short air bursts until water runs clean.

Heater Core

Flush heater core as described for radiator. Ensure heater control valve is set to maximum heat position before flushing heater.

REFILLING

To prevent air from being trapped in engine block, engine should be running when refilling cooling system. After system is full, continue running engine until thermostat is open, then recheck fill level. Do not overfill system.

TESTING

THERMOSTAT

1) Visually inspect thermostat for corrosion and proper sealing of valve and seat. If okay, suspend thermostat and thermometer in a 50/50 mixture of coolant and water. See Fig. 1. Do not allow thermostat or thermometer to touch bottom of container. Heat water until thermostat just begins to open.

2) Read temperature on thermometer. This is the initial opening temperature and should be within specification. Continue heating water until thermostat is fully open and note temperature. This is the fully opened temperature. If either reading is not to specification, replace thermostat.

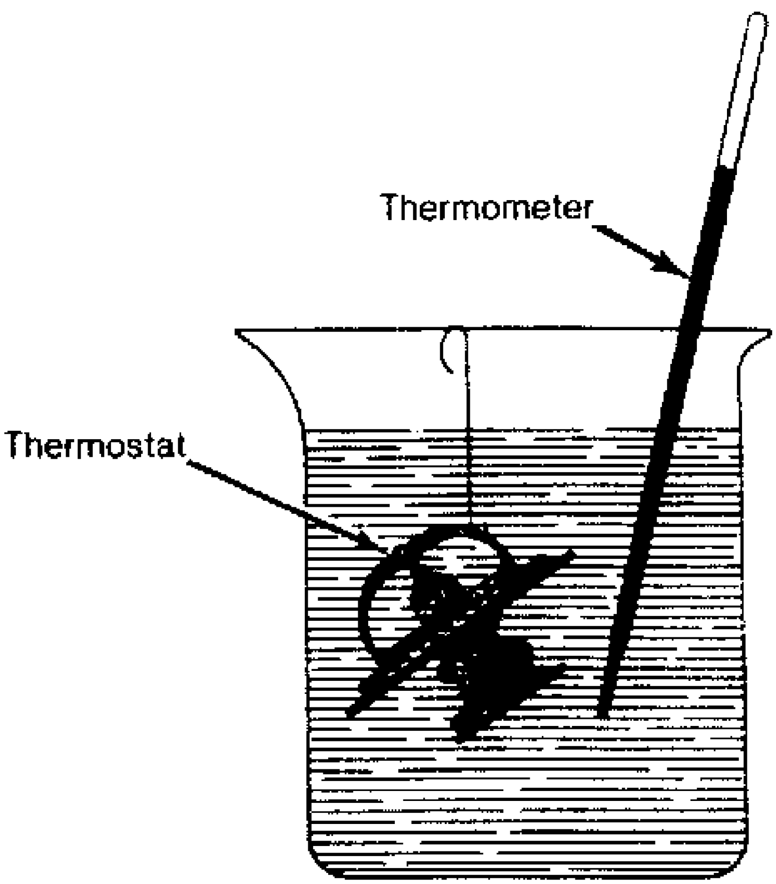


Fig. 1: Testing Thermostat in Anti-Freeze/Water Solution

PRESSURE TESTING

A pressure tester is used to check both radiator cap and

complete cooling system. Test components as follows, following tool manufacturer's instructions.

Radiator Cap

Visually inspect radiator cap, then dip cap into water and connect to tester. Pump tester to bring pressure to upper limit of cap specification. If cap fails to hold pressure, replace cap.

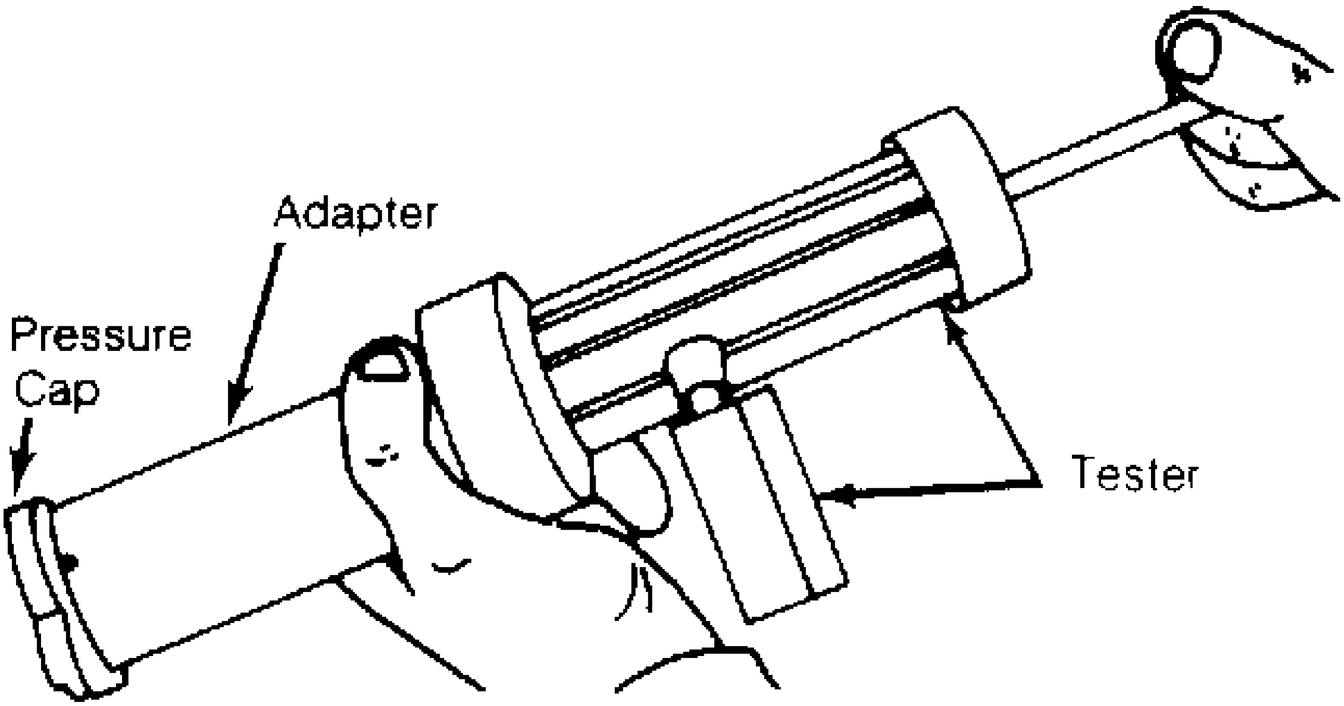


Fig. 2: Testing Radiator Pressure Cap

Cooling System

1) With engine off, wipe radiator filler neck seat clean. Fill radiator to correct level. Attach tester to radiator and pump until pressure is at upper level of radiator rating.

2) If pressure drops, inspect for external leaks. If no leaks are apparent, detach tester and run engine until normal operating temperature is reached. Reattach tester and observe. If pressure builds up immediately, a possible leak exists from a faulty head gasket or crack in head or block.

NOTE: Pressure may build up quickly. Release any excess pressure or cooling system damage may result.

3) If there is no immediate pressure build up, pump tester to within system pressure range (on radiator cap). Vibration of gauge pointer indicates compression or combustion leak into cooling system. Isolate leak by shorting each spark plug wire to cylinder block. Gauge pointer should stop or decrease vibration when leaking cylinder is shorted.

HEATER SYSTEM TROUBLE SHOOTING

1988 Jeep Cherokee

1989 HEATER SYSTEMS
Eagle Trouble Shooting

CONDITION & POSSIBLE CAUSE

Little or No Air From Heater Floor Outlets.

* Misadjusted heater air door cable.
* Obstructed heater housing or ducts.
* Clogged heater core fins.
* Leaking air duct seals.

Little or No Air From Defroster Outlets.

* Defroster duct misaligned.
* Defroster cable incorrectly adjusted
* Leaking air duct seals.
* Defroster duct damaged.

Heat Output When Controls Are Off.

* Outside air cable misadjusted
* Outside Air door binding in housing.

Not Enough Heat With Controls Fully On.

* Low coolant or plugged heater core.
* Incorrect thermostat.
* Incorrect adjustment of cables.
* Heater System Air Leaks.
* Blend air door not in proper position.

Blower Will Not Run.

* Blown fuse.
* Loose connections or poor ground.
* Faulty switch, motor or resistor.

Blower Runs But Does Not Circulate Air.

* Intake blocked..
* Fan not attached to motor shaft.

HEATER SYSTEM

1988 Jeep Cherokee

1988 HEATER SYSTEMS
Jeep

DESCRIPTION

Jeep vehicles use a blend-air type heater system. Wrangler models have a constant flow type system with engine coolant continuously flowing through heater core. Cherokee and Comanche use heater control valves. Coolant flow to heater core on these models can be stopped or diverted.

On all models, temperature of heated air entering passenger compartment is controlled by regulating amount of air flowing through heater core and then blending it with a controlled amount of cool air by-passing heater core.

CONTROL PANEL OPERATION

Control panel on all models includes fan switch, sliding temperature control lever and sliding mode lever.

DEFROSTER CONTROL

Defroster control operates heater housing door regulating heater and defroster operation by directing flow of air through defroster hose or floor outlets. When control knob is pushed in, blended air will enter passenger compartment through floor heat duct. When control is pulled completely out, door directs all heated air to windshield defroster outlets. Any intermediate position divides air flow between windshield and floor outlets.

TEMPERATURE CONTROL LEVER (CHEROKEE, COMANCHE & WRANGLER)

Lower control lever operates blend-air door in heater core housing. At full right position, all air is directed through heater core, providing maximum heat flow. At full left position, all air is directed around heater core providing fresh air. Control can be set in any intermediate position to provide a blend of heated and unheated air. With control lever in "COOL" position, water valve will close (except Wrangler). Mode control lever must be in "HEAT" or defroster mode before any air can enter vehicle.

MODE CONTROL LEVER (CHEROKEE & COMANCHE)

Mode control lever includes "BI-LEVEL", "VENT", "HEAT" and "OFF" positions. At far end of scale, a symbol for defroster indicates defrost position. In "BI-LEVEL" position, a mixture of floor heat and defroster air is obtained.

FAN CONTROL

Fan control is a 4-position control switch, regulating blower motor and air flow for heat and defrost. Switch has "LOW", "HIGH" and 2 intermediate positions. Fan will remain on unless mode lever is placed in "OFF" position.

CONTROL CABLES ADJUSTMENT

CHEROKEE & COMANCHE

The heater control cable is retained to blend air door lever with a retaining clip and a self-adjusting clip. During installation, self-adjusting clip will locate cable properly when cable is snapped into position on lever.

WRANGLER

The only adjustable cables are the vent door control cables. Since the left cable operates the right cable, the cables must be installed and adjusted in the proper order to maintain the self adjusting mechanism.

With cables connected to heater control panel, connect only the right vent door cable. Open and close right vent door one time, using heater control panel. Connect left side cable and ensure that both vent doors open at the same time.

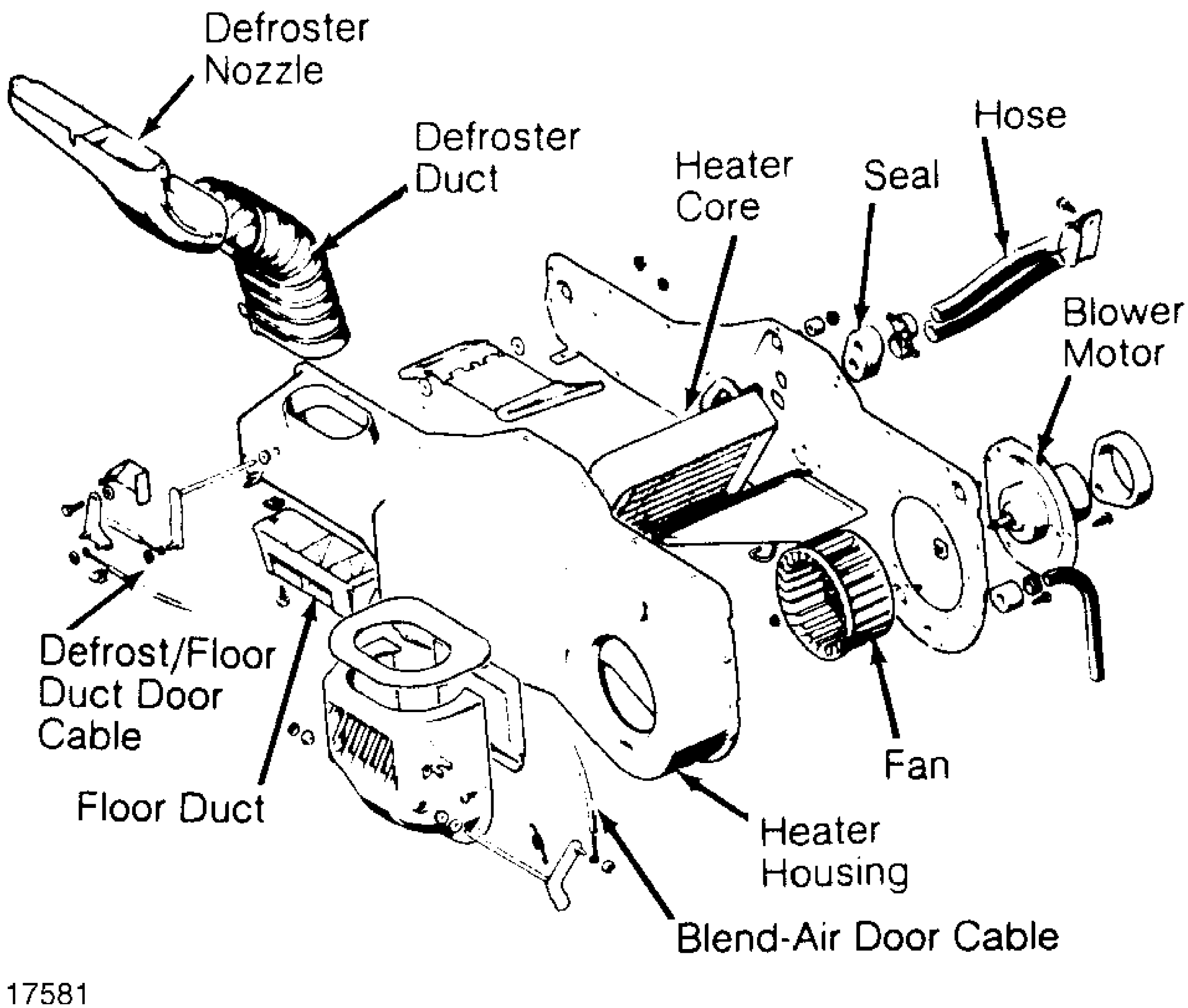


Fig. 1: Heater & Defroster Components (Wrangler)
Courtesy of Chrysler Motors.

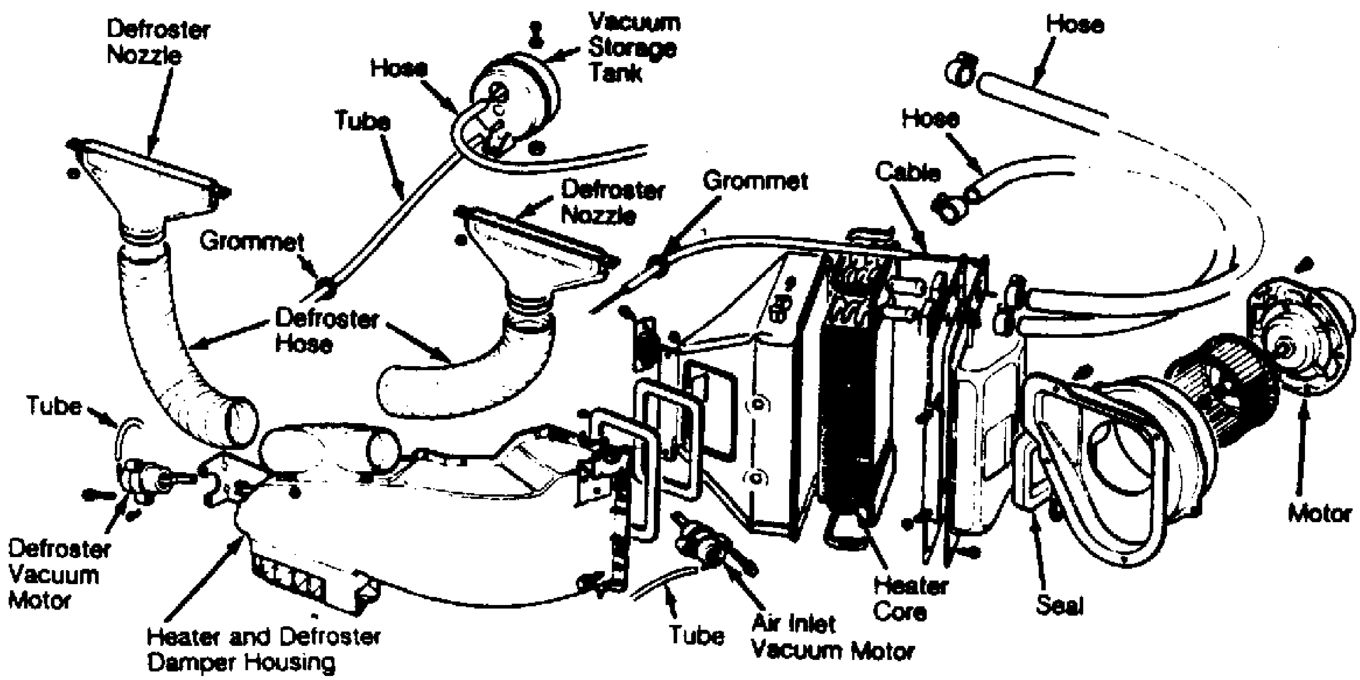


Fig. 2: Typical Heater & Defroster Components
Courtesy of Chrysler Motors.

BLOWER MOTOR R & I

NOTE: On Cherokee and Comanche, blower motor and fan are removed from engine compartment.

Removal & Installation

1) Remove heater core housing assembly. On all models, remove blower motor electrical connectors. Detach screws retaining blower motor assembly to heater housing. Remove blower motor and fan assembly. On Cherokee and Comanche, detach fan retaining clip from fan hub, if necessary. Remove fan from motor shaft.

2) To install, reverse removal procedure. If removed, ensure ears of retaining clip are over flat surface on motor shaft. Check blower motor and heater operation.

CONTROL PANEL R & I

Removal & Installation

1) Disconnect battery ground. On Cherokee, remove lower instrument panel. On all models, remove instrument panel bezel. On Cherokee, remove clock and radio (if equipped).

2) On all models, remove heater control panel attaching screws. Pull out control panel and disconnect vacuum hoses, wires and cables. Note locations for reassembly reference. Remove control panel. To install, reverse removal procedure.

CONTROL CABLES R & I

REMOVAL (CHEROKEE & COMANCHE)

Remove control panel. Detach cable from heater control panel.

Remove retaining clip and cable self-adjusting clip from blend-air door lever at bottom of blower housing. Remove cable by squeezing tabs with needle nose pliers. Do not break housing.

INSTALLATION

To install, connect cable self-adjusting clip to blend-air door lever, then snap cable into position. Install retaining clip onto blend-air door lever. Route cable to A/C-heater control panel and connect. Install control panel.

REMOVAL & INSTALLATION (WRANGLER)

1) Disconnect cables from vent doors. Disconnect cables from heater control panel levers. Remove cables by squeezing tabs with needle nose pliers.

2) Connect and adjust cables as described in ADJUSTMENTS section of this article

HEATER CORE R & I

REMOVAL & INSTALLATION (CHEROKEE & COMANCHE)

1) Disconnect battery ground. Drain cooling system. Disconnect heater hoses at heater core inlet and outlet tubes. Disconnect blower motor wires and vent tube. Remove console (if equipped). Remove lower instrument panel.

2) Disconnect electrical connectors from blower motor resistors. Disconnect vacuum hose at vacuum motor. Cut plastic retaining strap holding blower housing to heater core housing.

3) Disconnect and remove heater control cable. Detach clip at rear of blower housing flange and remove retaining screws. Remove housing mounting nuts from studs on engine compartment side of dash panel. Remove right kick panel.

4) Remove instrument panel support bolt. Gently pull on right side of dash, then rotate housing downward and toward rear of vehicle to disengage housing studs from dash panel. Remove blower housing. Detach retaining screws and remove heater core by pulling it straight out of housing.

5) To install, reverse removal procedure. Ensure seal is cemented in place to prevent movement when blower assembly is installed. Connect heater hoses and fill cooling system.

REMOVAL & INSTALLATION (WRANGLER)

1) Disconnect battery ground. Drain about 2 quarts of coolant from radiator. Disconnect heater hoses at heater core inlet and outlet tubes. Disconnect vent door cables. Disconnect blower motor wires. Disconnect defroster duct.

2) Remove nuts attaching heater housing studs to engine compartment side of dash panel. Remove heater housing assembly by tilting it downward, to disengage it from defroster duct.

3) Pull heater housing rearward and out from under instrument panel. Remove heater housing cover from heater housing assembly. Remove heater core from housing.

HEATER SYSTEM OPREATION CHART & VACUUM DIAGRAM

HEATER SYSTEM OPERATION TABLE

MODE						

LEVER POSITION	AIR DISCHARGE	BLOWER SPEEDS	PANEL DOOR	FLOOR DOOR	DEFROST DOOR	WATER VALVE
Off	Closed	None	Closed	Closed	Closed	Closed
Vent	Panel Registers	4	Open	Closed	Closed	Closed
Bi-Level	Panel Registers and Floor With Def. Bleed	4	Open	Open	Bleed	Open(1)
Heat	Floor With Def. Bleed	4	Closed	Open	Bleed	Open(1)
Def.	Defroster	4	Closed	Closed	Open	Open(1)
(1) - Water valve closes in full "COOL" temperature lever position.						

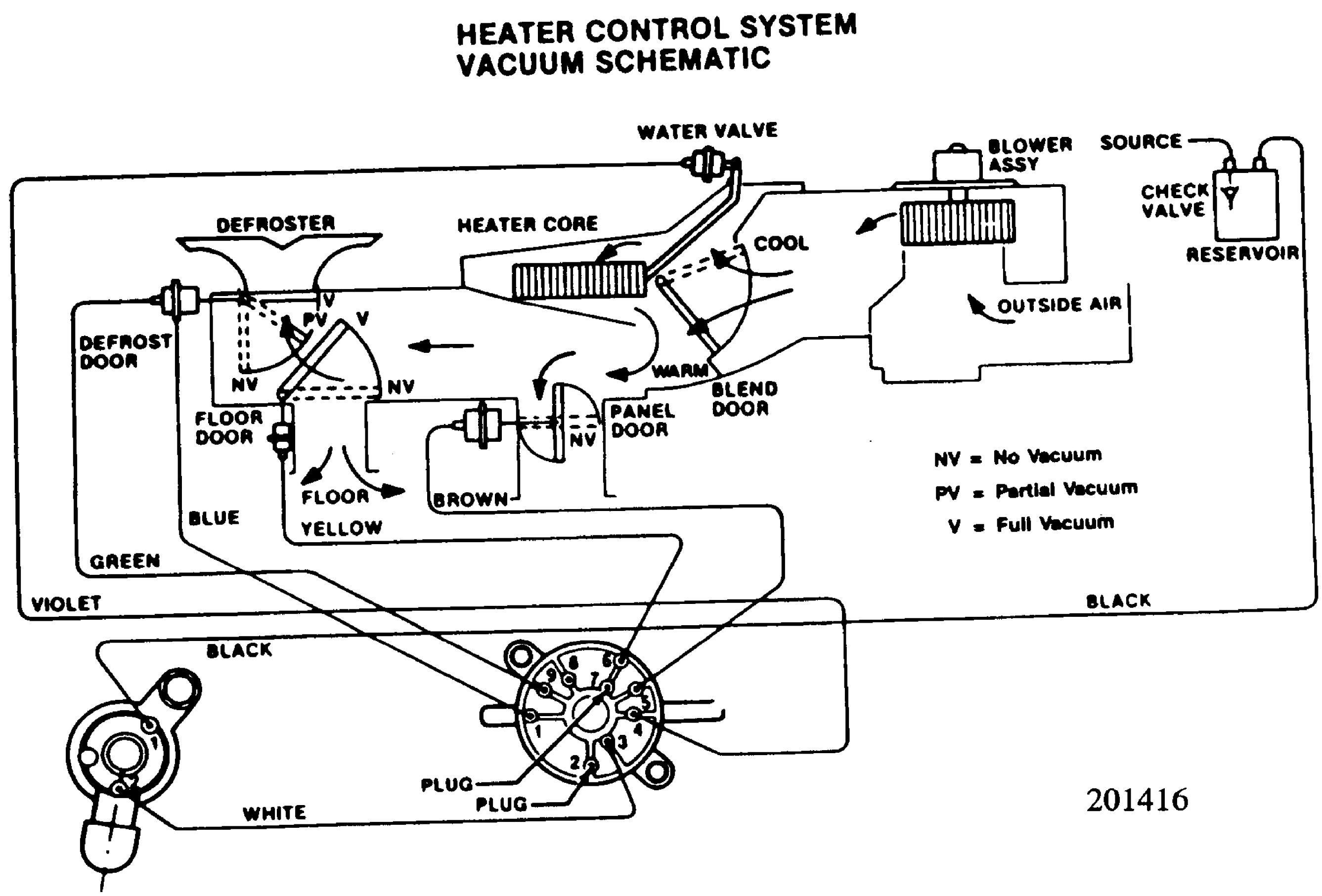


Fig. 3: Heater Control System Vacuum Diagram

WIRING DIAGRAMS

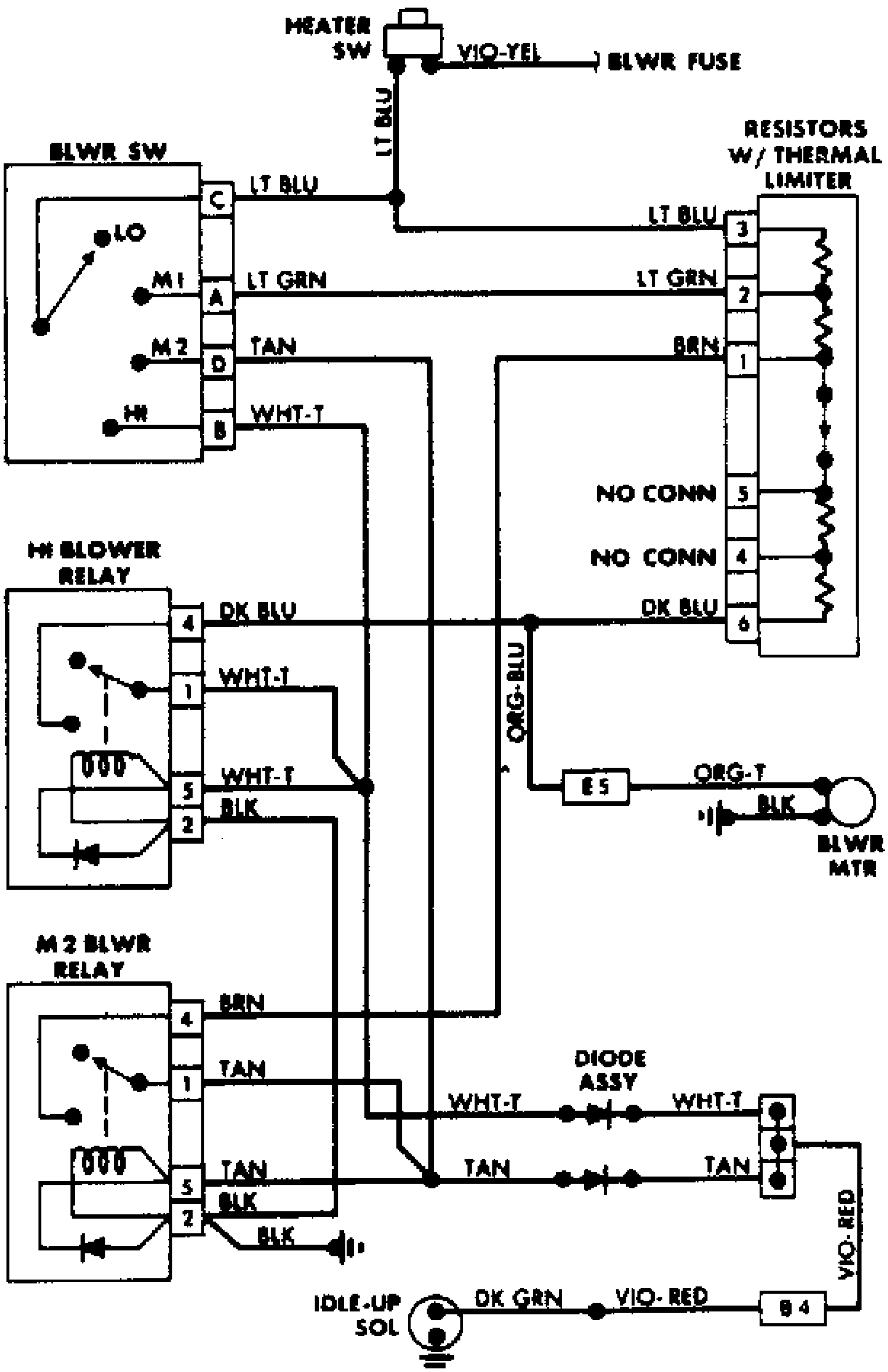


Fig. 4: Heater Wiring Diagram (Comanche Diesel)

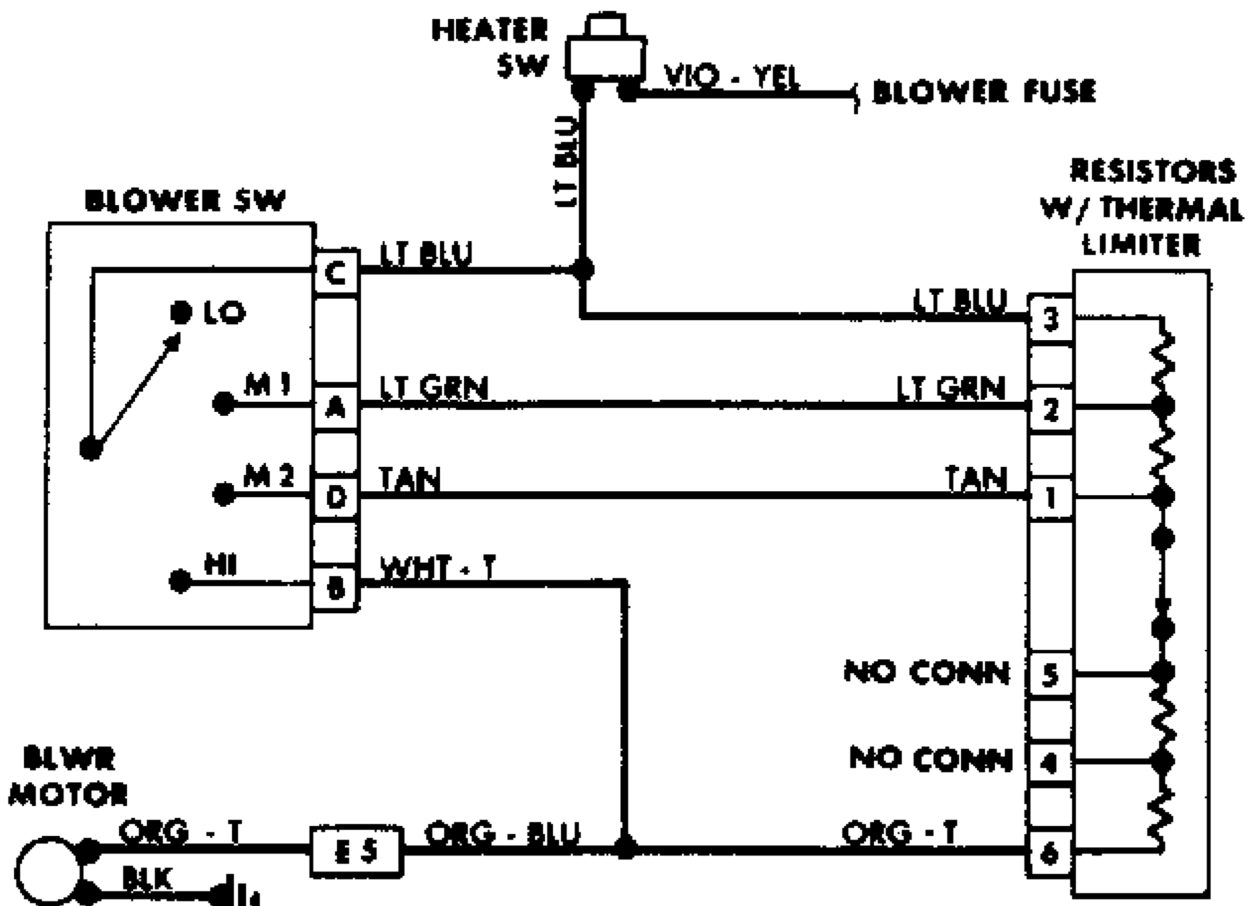


Fig. 5: Heater Wiring Diagram (Comanche Gas)

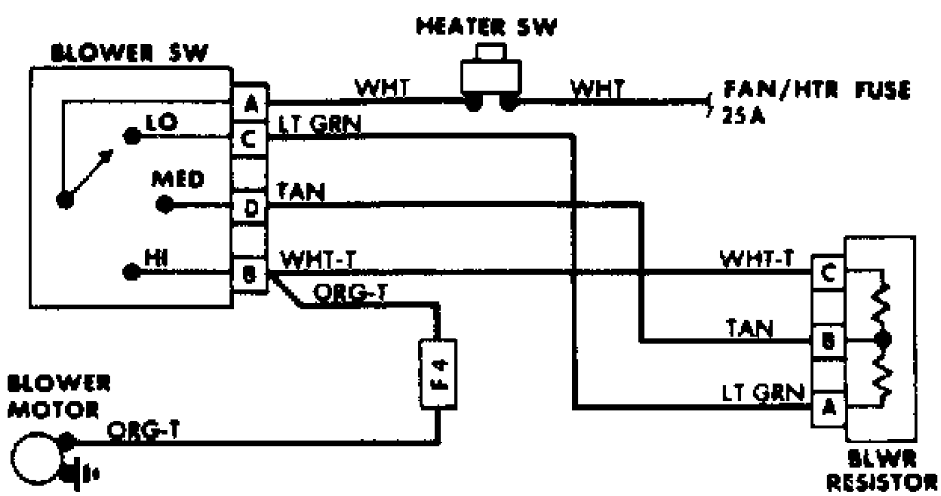


Fig. 6: Heater Wiring Diagram (Wrangler)

IGNITION SWITCH & LOCK CYLINDER

1988 Jeep Cherokee

1988 Ignition Switch & Lock Cylinders
JEEP

DESCRIPTION

The ignition switch and lock cylinder is typically mounted on the steering column and actuated by an ignition key.

SERVICING

To gain access to ignition components on Jeep vehicles, the steering column must be removed or lowered and the turn signal switch must be removed.

CAUTION: The lock plate is held by high spring pressure. DO NOT remove snap ring without using a compressor tool. If the steering shaft has standard threads, use Compressor Tool (J-23653); if the shaft has metric threads use Metric Forcing Screw (J-23653-4).

CAUTION: Special care must be taken to avoid bumping, jolting or hammering on the steering shaft and gearshift tube.

REMOVAL & INSTALLATION

LOCK CYLINDER

Removal

Turn lock cylinder clockwise 2 detent positions beyond "OFF-LOCK" position. Compress lock cylinder retaining tab using a thin bladed screwdriver and remove lock cylinder.

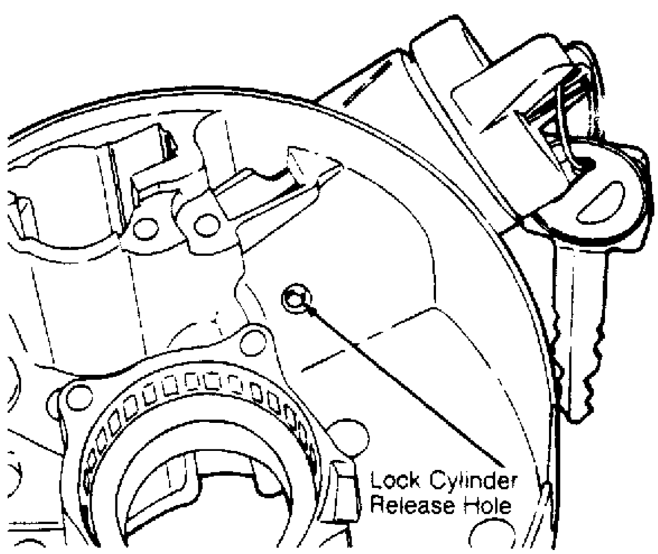


Fig. 1: Typical Column Type Ignition Switch Lock Cylinder Removal
On most vehicles, push in to release lock retainer.

Installation

Insert key in lock. Hold cylinder sleeve, and turn key

clockwise until key stops. Insert cylinder lock into bore with cylinder tab aligned with keyway in housing. Push cylinder in until it bottoms. Rotate cylinder counterclockwise to engage lock sector, and push in until cylinder tab engages in housing groove.

IGNITION SWITCH

Removal

Lower column and remove switch mounting screws. Disconnect harness connector. Remove switch.

Installation

Move switch slider to "ACC" position. Move switch slider back 2 clicks to "OFF-UNLOCK" position. Insert remote rod in switch slider, and position switch on column. Do not move slider. Install and tighten screws.

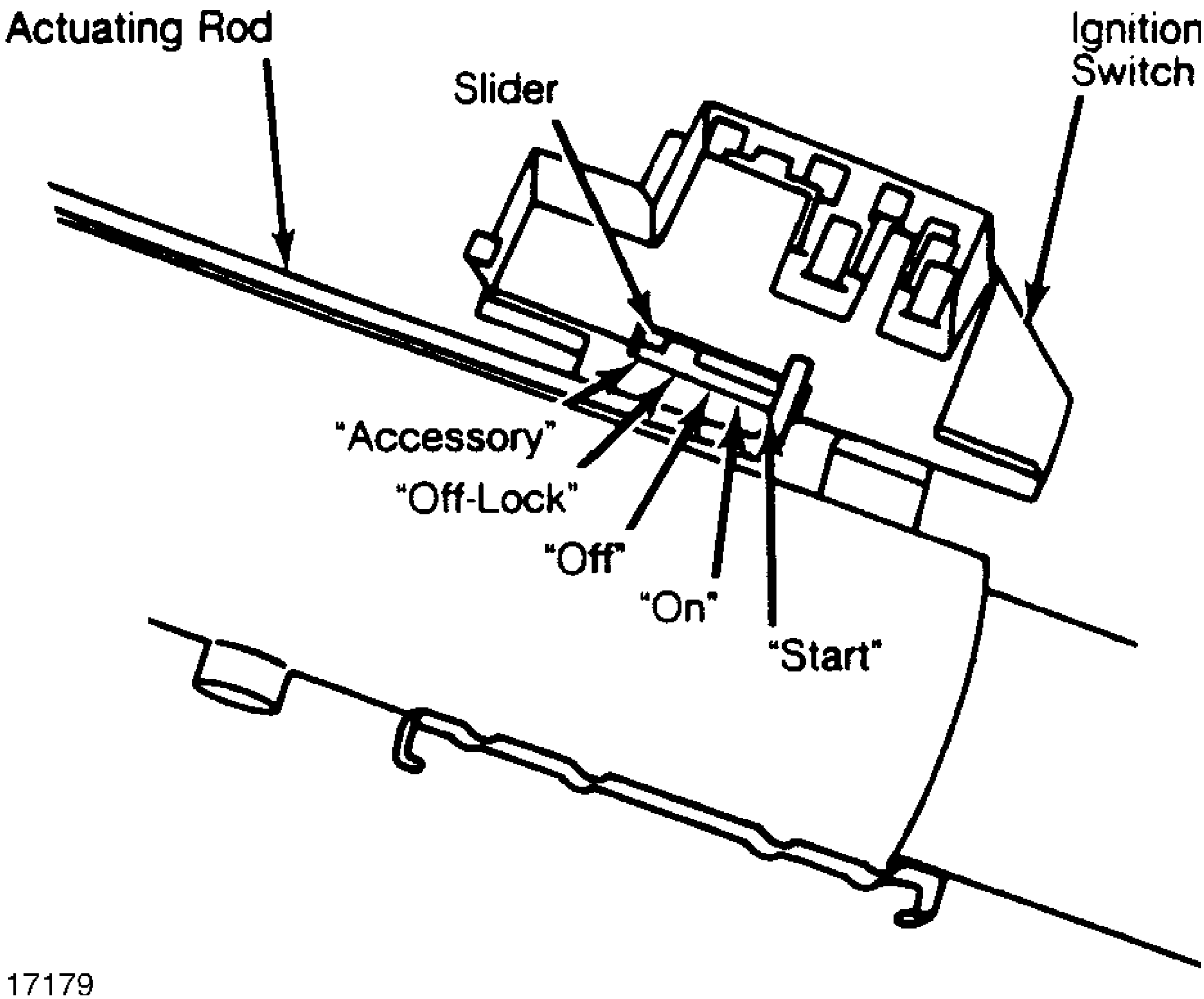


Fig. 2: Rod-Actuated Ignition Switch

IGNITION SYSTEM - 2.5L W/RENIX ELECTRONIC IGNITION

1988 Jeep Cherokee

Distributors & Ignition Systems
JEEP RENIX ELECTRONIC IGNITION

2.5L TBI: Cherokee, Comanche, Wagoneer, Wrangler

DESCRIPTION

The Renix electronic ignition system consists of a solid-state Ignition Control Module (ICM), a distributor, a Top Dead Center (TDC) sensor, and an Electronic Control Unit (ECU).

OPERATION

IGNITION CONTROL MODULE (ICM)

The ignition control module is located in engine compartment, just left of battery. The ICM consists of a solid-state ignition circuit and an integrated ignition coil that can be removed and serviced separately.

Electronic signals from the electronic control unit to the ICM determine the amount of ignition timing or retard needed to meet various engine requirements. The electronic control unit provides an input signal to the ICM. The ICM has only 2 outputs: a tach signal to the tachometer and diagnostic connector, and a high voltage signal from the coil to the distributor cap.

TDC SENSOR

The TDC sensor senses TDC and BDC crankshaft positions as well as engine RPM. Sensor is located on left rear side of engine and is not adjustable. Sensor is secured by special shouldered bolts to flywheel/drive plate housing.

TESTING

1) Disconnect ignition coil wire from center tower of distributor cap. Using insulated pliers, hold coil wire about 1/2" (13 mm) away from engine block. Crank engine and check for spark between wire and engine block.

2) If spark occurs, reconnect coil wire to distributor cap. Remove spark plug wire from one spark plug. Using insulated pliers, hold wire about 1/2" (13 mm) away from engine block.

3) Crank engine and check for spark between wire and engine block. If spark occurs, check fuel system for problems. If no spark occurs, check for a defective rotor, distributor cap, or spark plug wires. Replace parts as necessary.

4) If rotor, cap and wires are okay, check for loose or corroded connections at coil terminals. If necessary, clean terminals and wires. Ensure wires are properly seated on coil terminals and not wedged between coil body and terminal. If okay, go to next step.

5) Check for loose connectors at ICM or ECU. Verify that wire connectors are firmly plugged into ICM and ECU. Also check for loose ICM or ECU ground wire connections at oil dipstick bracket. Clean and tighten if necessary.

6) Load test battery to ensure battery is fully charged. Replace battery if necessary. If battery is okay, check voltage between terminals "A" and "B" of ICM connector while cranking engine. See Fig. 1.

7) Minimum voltage reading should be 9.5 volts. If voltage is okay, go to next step. If voltage is low, check continuity of ICM and ECU ground wires. Repair or replace as necessary.

8) Using an ohmmeter, check ignition coil resistance. Resistance on primary winding should be .4-.8 ohms. Secondary resistance should be 2500-4000 ohms. If correct, go to next step. If not, replace ignition coil.

9) Check ECU and ICM with Tester (MS 1700). Replace ICM or ECU if either fails MS 1700 test sequence.

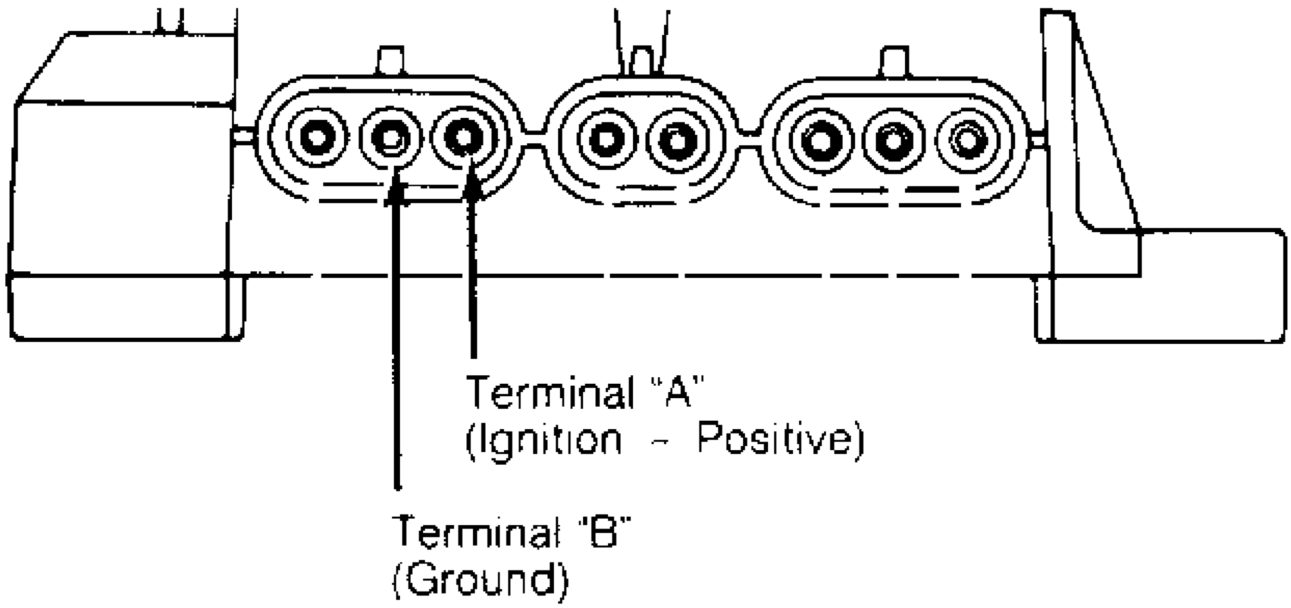


Fig. 1: 2.5L TBI ICM Connector Terminals
Courtesy of American Motors/Jeep Corp.

OVERHAUL

NOTE: The 2.5L TBI distributor contains no electrical components other than the rotor and distributor cap. If any other distributor part is defective, the entire distributor assembly must be replaced.

DISTRIBUTORS & IGNITION SYSTEMS
Jeep Solid State Ignition

4.0L 6-Cylinder

DESCRIPTION

IGNITION SYSTEM GENERAL DESCRIPTION

The Solid State Ignition (SSI) system features a solid state Ignition Control Module (ICM)/ignition coil assembly, Electronic Control Unit (ECU), distributor and engine speed sensor. Other components include the battery, ignition switch, starter solenoid, spark plugs and wires, cap and rotor, resistance wire, by-pass wire and a knock sensor. A sync pulse signal generator (stator) inputs the firing order to the ECU.

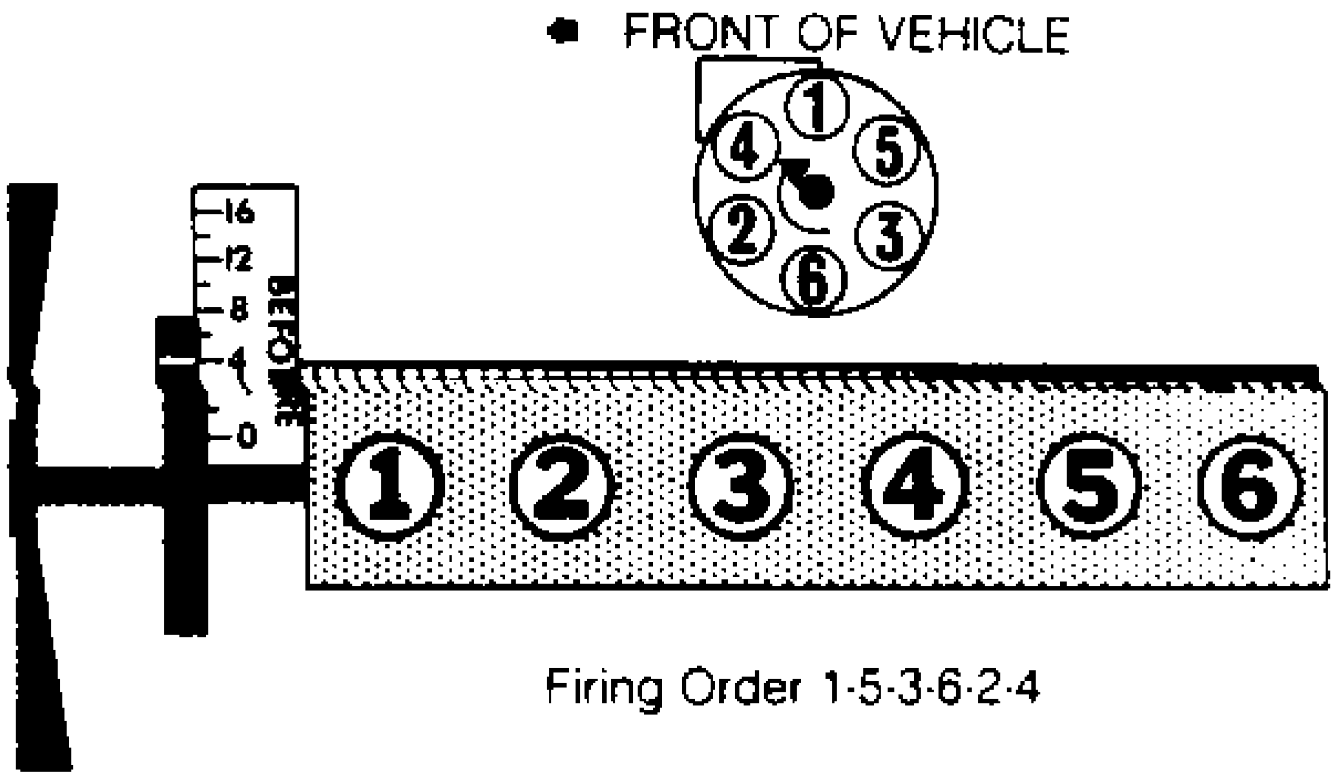


Fig. 1: 4.0L 6-Cylinder Firing Order

IGNITION CONTROL MODULE (ICM)

The ignition control module is mounted to the ignition coil. See Fig. 2. Based on control system inputs, the ECU triggers the ignition coil via the ignition control module. The ECU is able to advance or retard ignition timing by controlling the ignition coil through the ignition control module.

The ICM consists of a solid state ignition circuit, an integrated ignition circuit and an integrated ignition coil that can be removed and serviced separately if necessary.

The ECU provides an input signal to the ICM. The ICM has only two outputs:

* Tach signal to the tachometer and diagnostic connector
* High voltage from the coil to the distributor cap

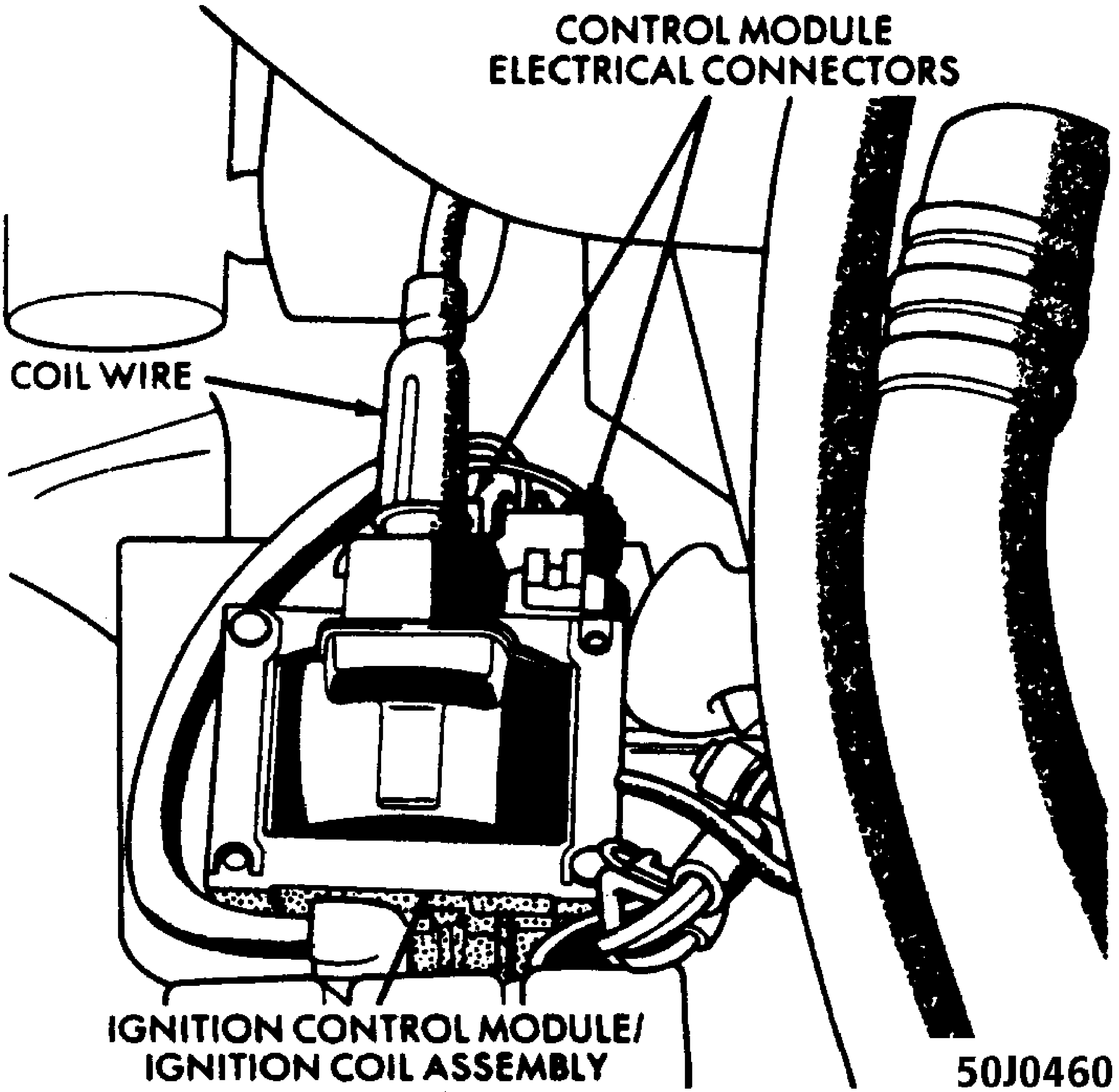


Fig. 2: View of Ignition Control Module/Ignition Coil Assembly

IGNITION CONTROL MODULE (ICM) ELECTRICAL FEED CONNECTIONS

Electrical feed to the ICM is through terminal "A" of Connector No. 1 on the module. See Fig. 3.

NOTE: Electrical supply only occurs with the ignition switch in the START and RUN position.

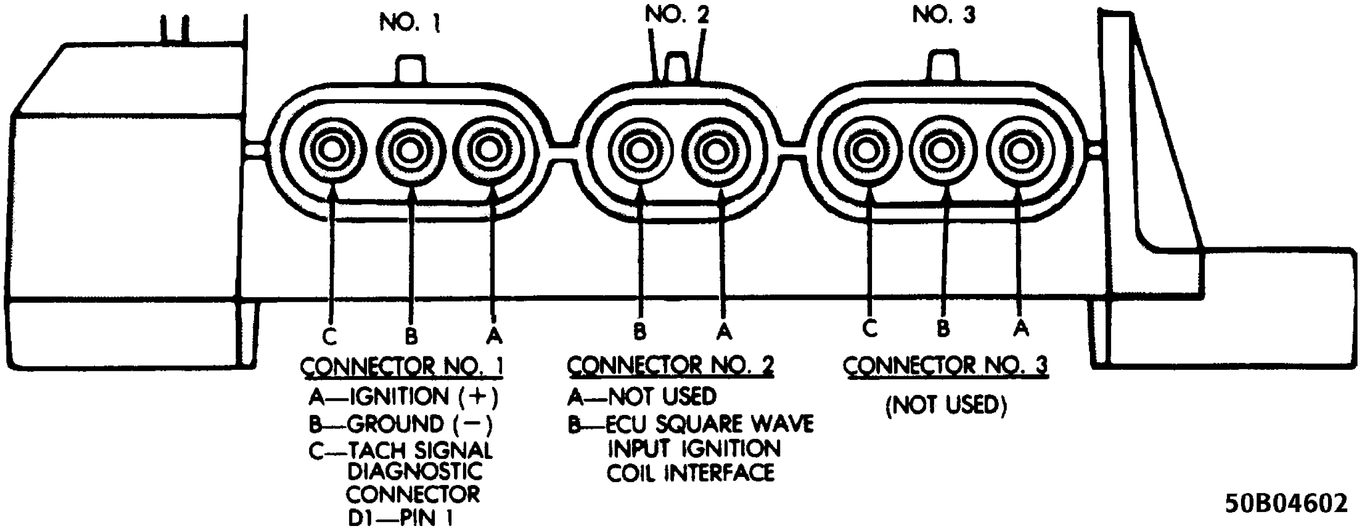


Fig. 3: Ignition Control Module Connector Identification
Courtesy of Chrysler Motors.

Terminal "B" of Connector No. 1 is grounded at the engine oil dipstick bracket along with the ECU ground wire and Oxygen (O2) sensor ground.

The tachometer output signal wire of the ICM is connected to Pin No. 1 of the "D1" Diagnostic connector. The wire is routed to the diagnostic connector through a short section of the ECU harness, the engine, and the instrument panel harness. This type of routing eliminates any potential electrical interference from occurring in the various ECU circuitry.

Ignition firing signals from ECU terminal "27" are transmitted through terminal "B" of Connector No. 2 on the ICM. the ignition signal from the ECU is received by the ICM in the form of a 5 volt square wave. As the leading edge of the wave contacts the ignition circuitry in the ICM, the ICM charges the coil primary windings.

When coil saturation occurs, the module circuitry opens the primary windings to collapse the magnetic field in the windings. This induces the coil secondary windings which is then transmitted to the spark plug via the coil wire, distributor cap, and rotor.

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR

The MAP sensor reacts to absolute pressure in the intake manifold and provides an input signal to the ECU. As the engine load changes, manifold pressure varies, which causes the MAP sensor resistance to change, resulting in a different input voltage to the ECU. The input voltage level supplies the ECU with information relating to ambient barometric pressure during engine start-up or regarding engine load while the engine is running. The ECU calculates this information and adjusts the air-fuel mixture accordingly.

The MAP sensor is mounted under the hood on the firewall and is connected to the throttle body with a vacuum hose. See Fig. 4.

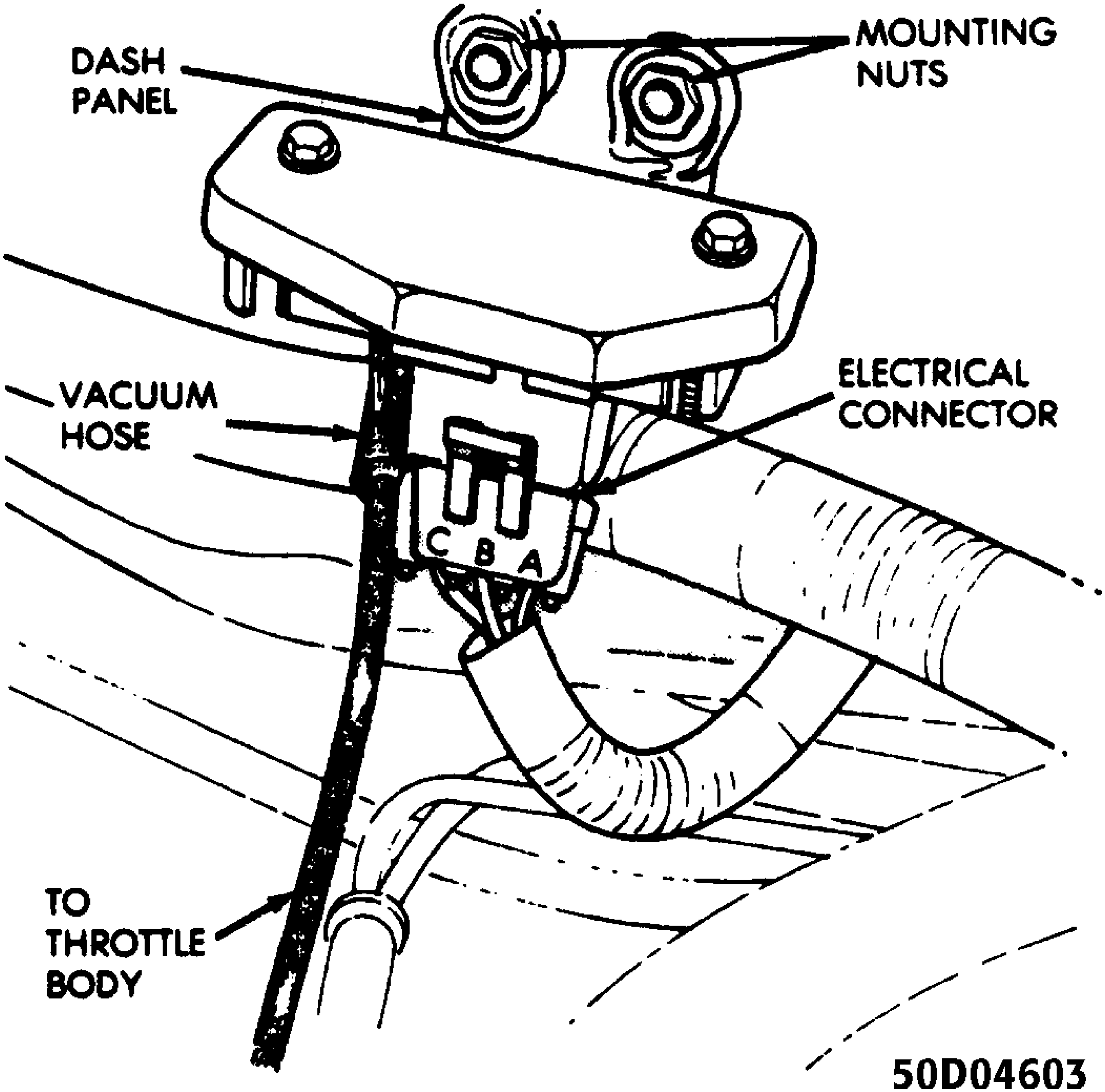


Fig. 4: View of Manifold Absolute Pressure (MAP) Sensor
Courtesy of Chrysler Motors.

COOLANT TEMPERATURE SENSOR (CTS)

The coolant temperature sensor is installed in the engine water jacket on the left side of the engine. See Fig. 5. It provides an input voltage to the ECU. As coolant temperatures vary, the Coolant Temperature Sensor resistance changes, resulting in a different input voltage to the ECU. The ECU calculates this information and adjusts the following:

* Adjust fuel injector pulse width. Colder coolant

temperatures will result in longer injector pulse width and richer air-fuel mixtures.

* Compensate for fuel condensation in the intake manifold.
* Control engine warm-up idle speed.
* Increase ignition advance when the coolant is cold.
* Energize the EGR valve solenoid, thus preventing the flow of vacuum to the EGR valve.

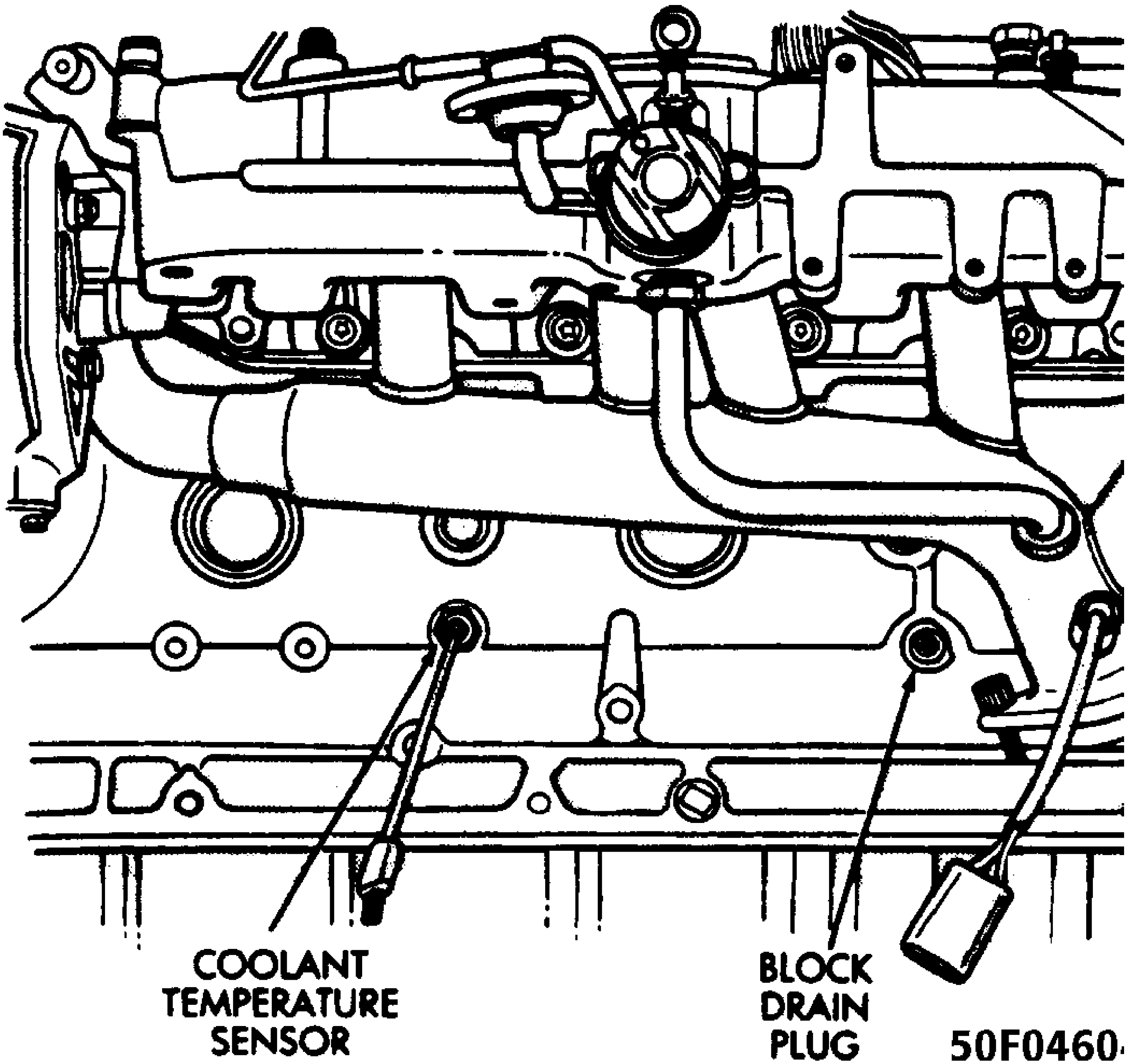


Fig. 5: Location of Coolant Temperature Sensor (CTS)
Courtesy of Chrysler Motors.

MANIFOLD AIR TEMPERATURE (MAT) SENSOR

The Manifold Air Temperature (MAT) sensor is installed in the intake manifold with the sensor element extending into the air-fuel

stream See Fig. 6. The MAT sensor provides an input voltage to the ECU. As the temperature of the air-fuel stream in the manifold varies, resistance changes, resulting in a different input voltage to the ECU.

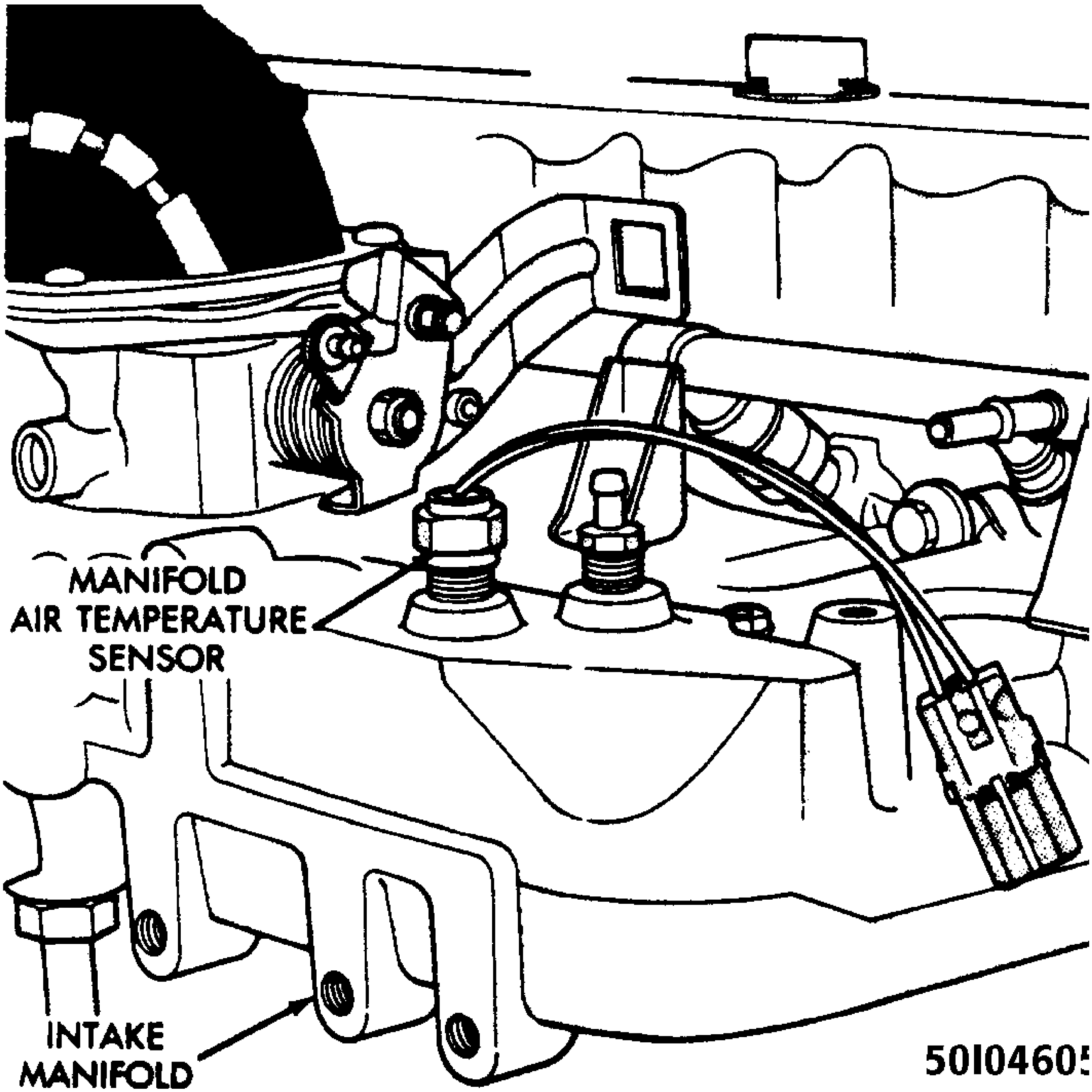


Fig. 6: Location of Manifold Air Temperature (MAT) Sensor
Courtesy of Chrysler Motors.

ENGINE SPEED SENSOR (CRANKSHAFT POSITION SENSOR - CPS)

The engine speed sensor is attached to the flywheel cover housing and provides an input signal to the ECU relating to crankshaft speed, angle, and position. See Fig. 7. The ECU converts crankshaft speed input into engine RPM and converts crankshaft angle to piston

position. The engine speed sensor senses TDC, BDC, and engine speed by detecting the flywheel teeth as they pass by the sensor during engine operation. The engine speed sensor is non-adjustable.

The flywheel has three trigger notches, 120° apart. See Fig. 7. There are 20 small teeth between each trigger notch. Each large trigger notch is located 12 small teeth before each Top Dead Center (TDC) position of the corresponding pistons.

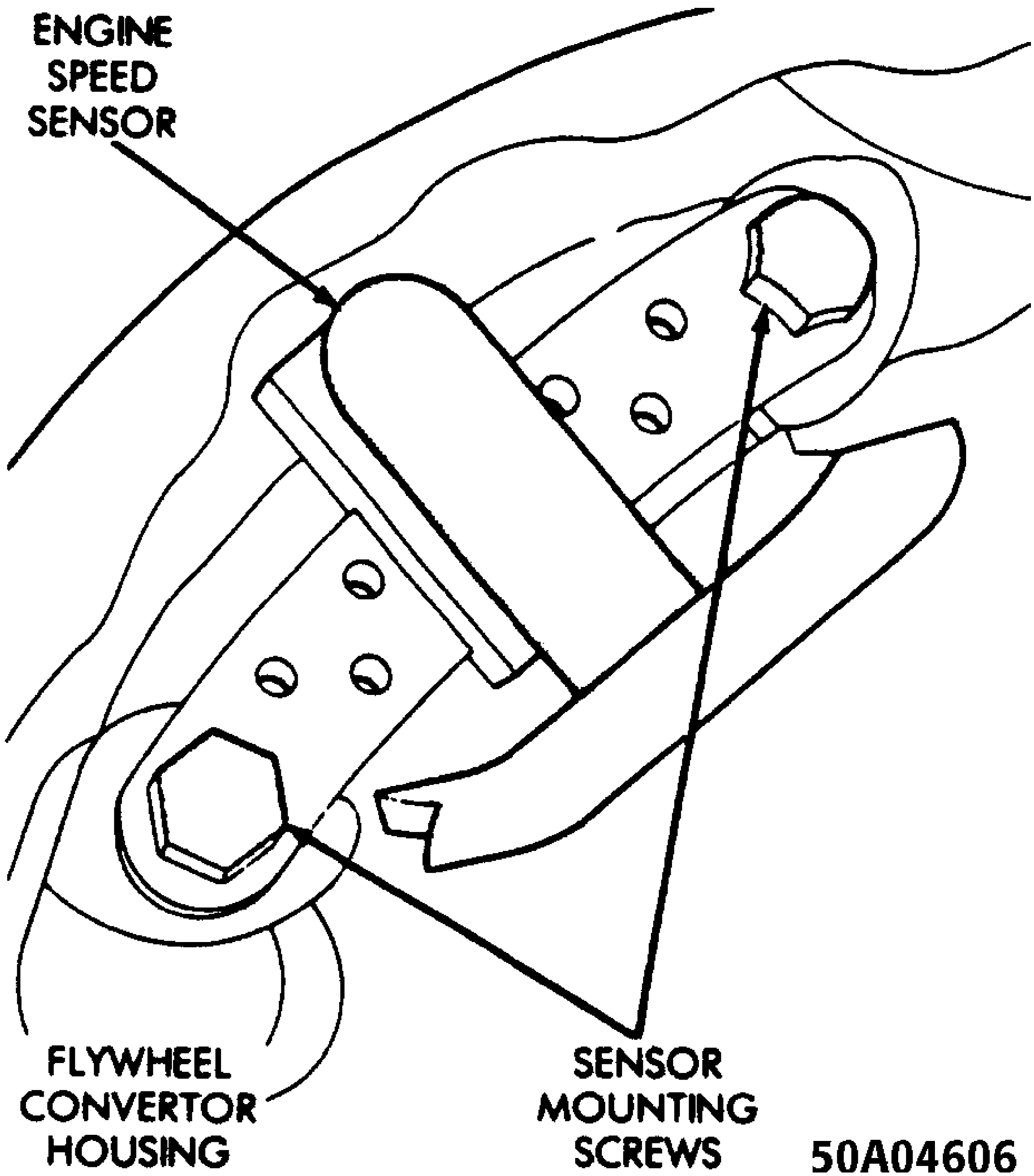


Fig. 7: Location of Engine Speed Sensor
Courtesy of Chrysler Motors.

When a small tooth and notch pass the magnet core in the sensor, the concentration, followed by the collapse of the magnetic

flux induces a small voltage spike to the sensor pickup coil winding. These small voltage spikes enable the ECU to count the teeth as they pass the sensor. When a large trigger tooth and notch pass the magnetic core in the sensor, the increased concentration, and then collapse of the magnetic flux induces a higher voltage spike into the sensor pickup coil winding. See Fig. 8.

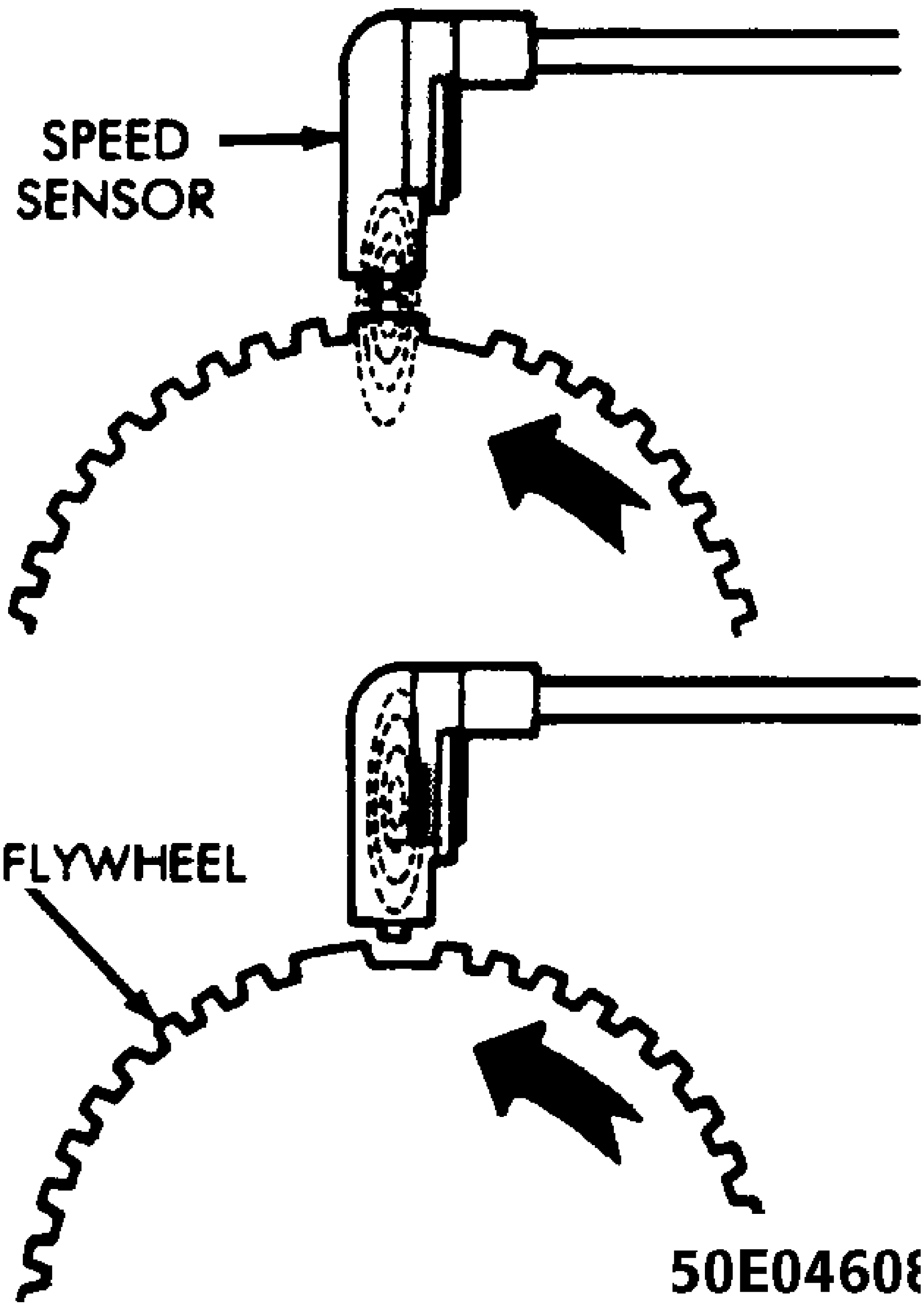


Fig. 8: Engine Speed Sensor Operation
Courtesy of Chrysler Motors.

The higher voltage spike is an indication to the ECU that a piston will reach its TDC position, 12 teeth later. See Fig. 9. The

ignition timing for the particular cylinder is either advanced or retarded as necessary by the ECU according to sensor inputs.

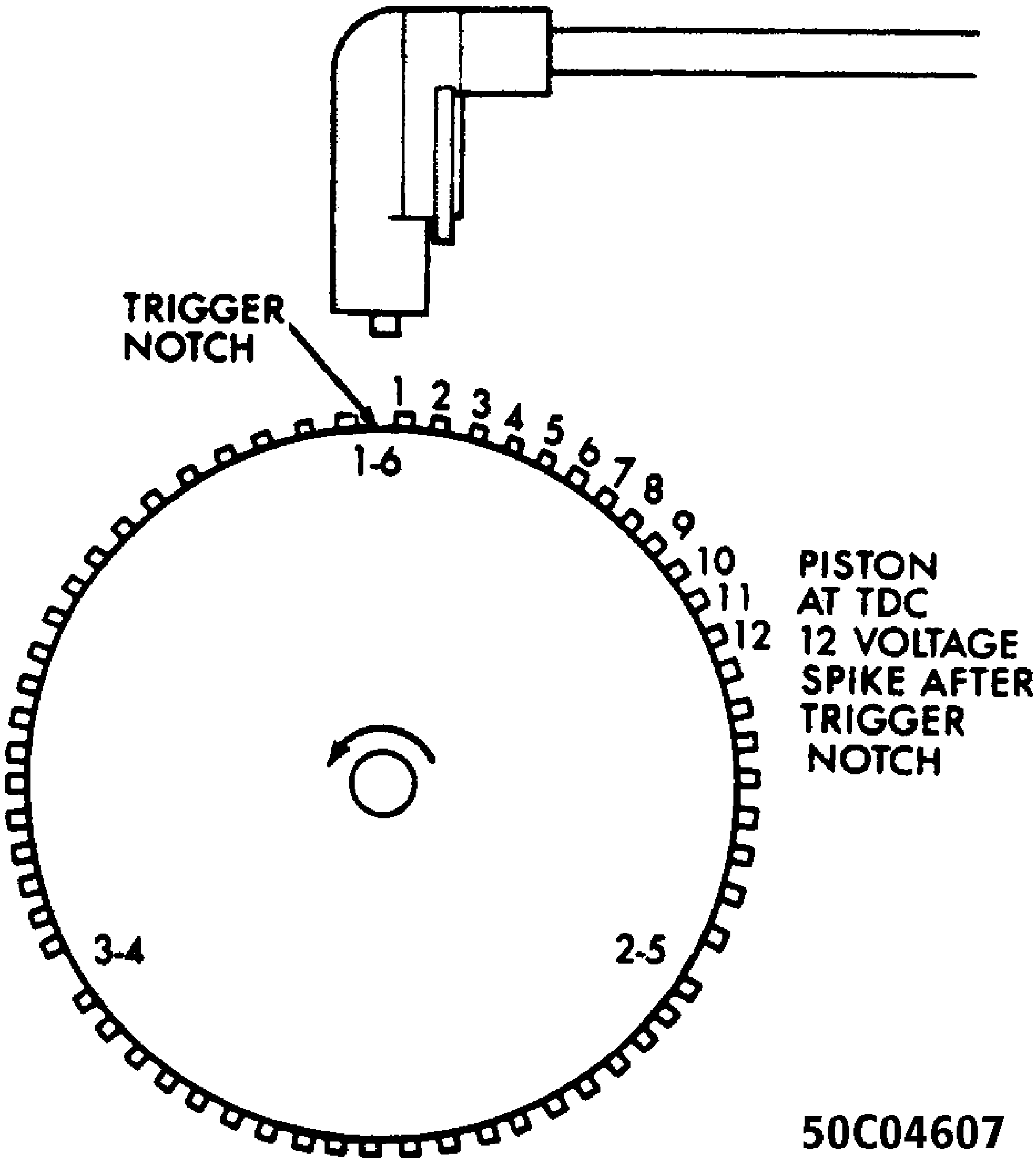


Fig. 9: View of Engine Speed Sensor, Showing Trigger Notches & TDC Position
Courtesy of Chrysler Motors.

SYNC PULSE SIGNAL GENERATOR (STATOR)

The sync pulse signal generator is located in the distributor and works in conjunction with the engine speed sensor to provide the ECU with input to establish and maintain correct injector firing order. See Fig. 10. A pulse ring mounted to the distributor shaft references the position of pistons one and six as it rotates through the sync pulse signal generator's magnetic field.

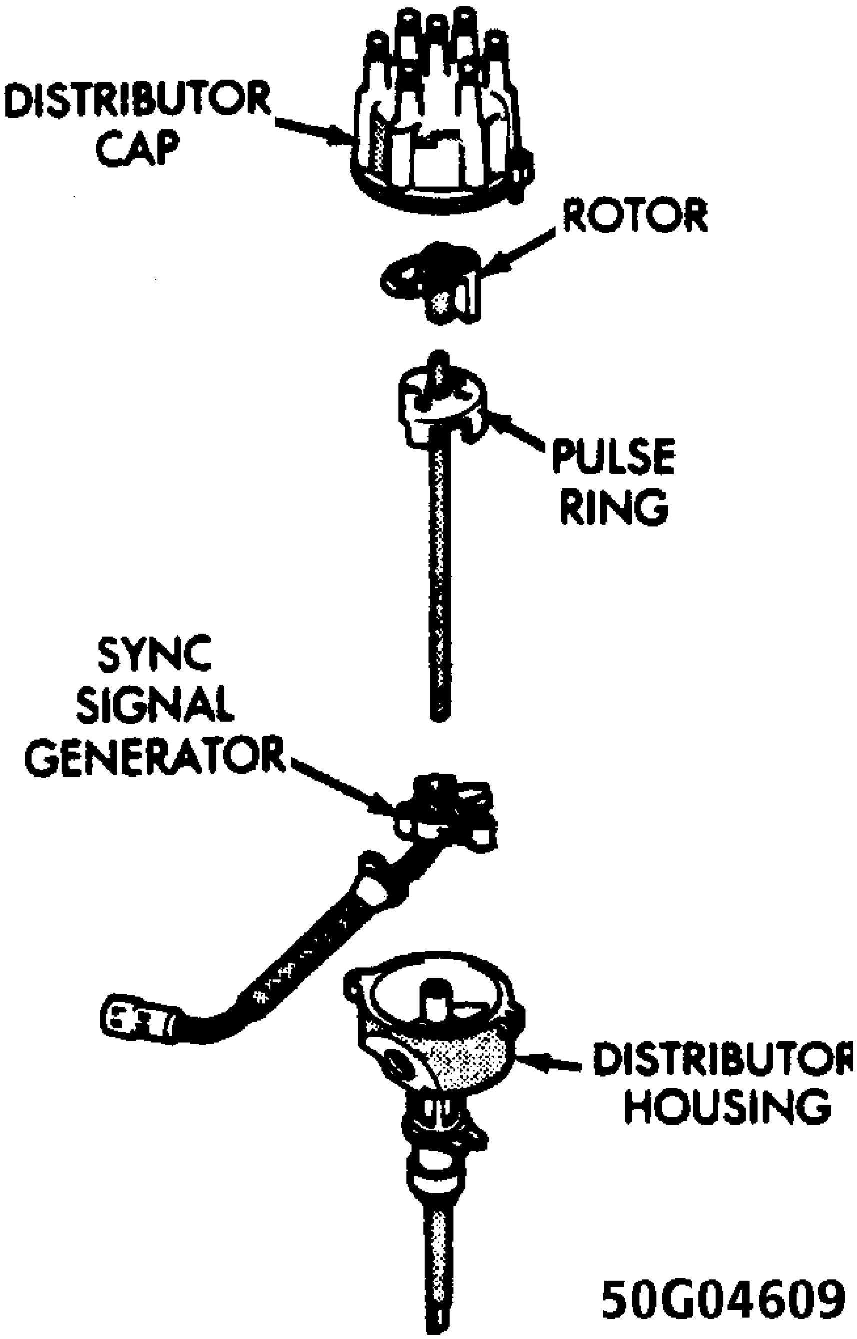


Fig. 10: Location of Sync Pulse Signal Generator & Pulse Ring
Courtesy of Chrysler Motors.

The pulse ring rotates through the sync pulse signal generator for 180°. When the leading edge of the pulse enters the sync

pulse signal generator, the magnetic field becomes weaker. This indicates the position of piston number one to the ECU. When the trailing edge of the pulse ring leaves the sync pulse signal generator, the magnetic field becomes stronger. This indicates the position of piston number six.

The sync pulse signal input and engine speed sensor input allow the ECU to establish the necessary reference point to synchronize the fuel injection.

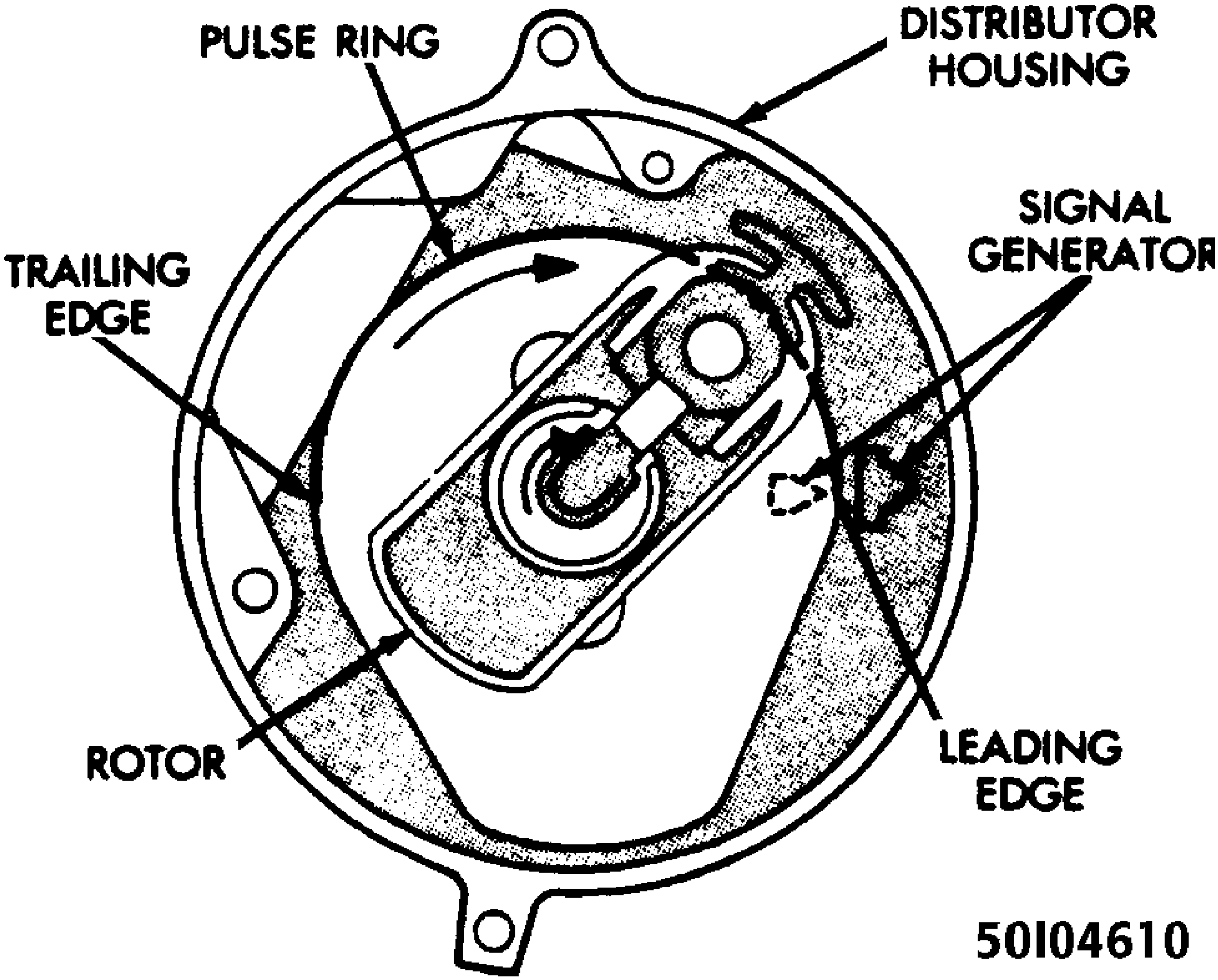


Fig. 11: Sync Pulse Signal Generator Operation
Courtesy of Chrysler Motors.

KNOCK SENSOR

The knock sensor is located on the lower left side of the engine block just above the oil pan. See Fig. 12. The knock sensor provides an input to the ECU, indicating detonation (knock) during engine operation. When knock occurs, the ECU retards the ignition advance to eliminate the knock at the appropriate cylinder(s).

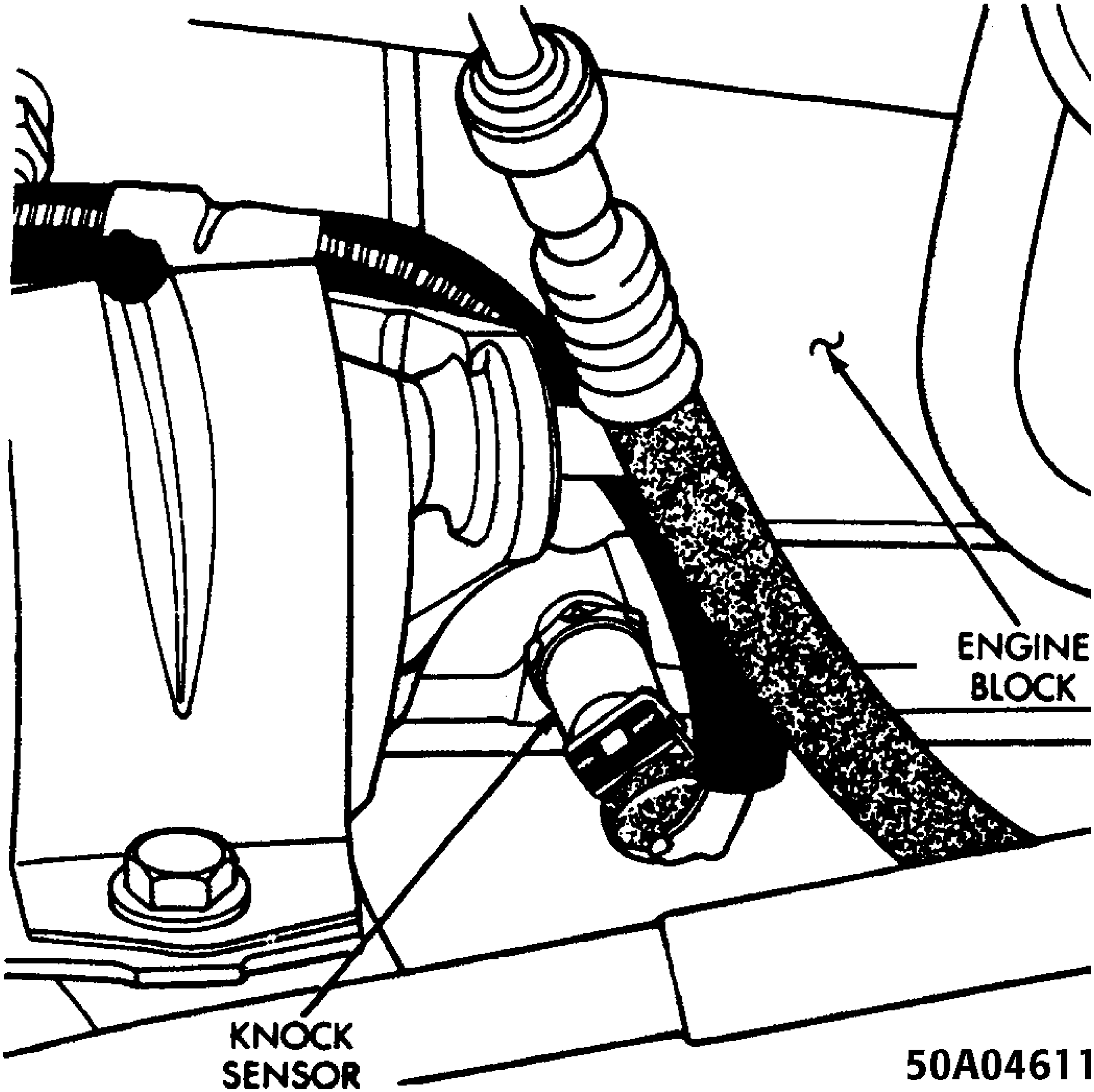


Fig. 12: Location of Knock Sensor
Courtesy of Chrysler Motors.

IGNITION SYSTEM PRECAUTIONS

When disconnecting wire from spark plug or distributor cap, twist rubber boot slightly to loosen. Grasp boot (not wire) and pull with steady, even force.

When separating control unit connectors, pull with firm, straight force. Do not pry apart with screwdriver. When connecting, press together firmly to overcome hydraulic pressure of silicone grease.

If connector locking tabs weaken or break, press together firmly and bind with electrical tape or a harness tie strap to assure good connection.

COMPONENT LOCATIONS

COMPONENT LOCATIONS

Component	Location
Coolant Temperature Sensor (CTS)	On left side of engine
Engine Speed Sensor	Attached to flywheel cover housing
Ignition Control Module	Mounted to ignition coil
Knock Sensor	On lower left side of engine
Manifold Absolute Pressure (MAP) Sensor	Under the hood, on firewall
Manifold Air Temperature (MAT) sensor	On intake manifold
Sync Pulse Signal Generator	Inside distributor

TESTING

BASIC DIAGNOSTIC PROCEDURES

This section contains information for determining individual system component performance. Diagnosis of ECU/Engine Control System is performed using the DRB-II Diagnostic Tester. See the appropriate Computerized Engine Control System article in this section.

COOLANT TEMPERATURE SENSOR (CTS) TEST

1) Disconnect the CTS wire harness connector from the CTS. See Fig. 13.

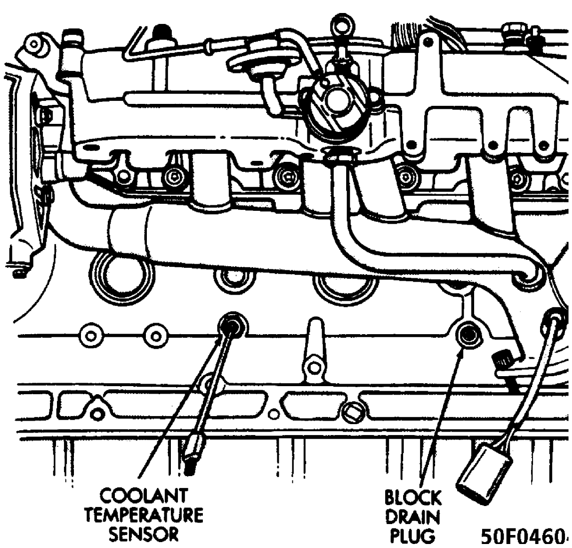


Fig. 13: Location of Coolant Temperature Sensor (CTS)
Courtesy of Chrysler Motors.

2) Using a high input impedance (digital) volt-ohmmeter, test the resistance of the sensor. Resistance should be less than 1000 ohms

with a warm engine. See the COOLANT TEMPERATURE SENSOR (CTS) RESISTANCE VALUES table below.

COOLANT TEMPERATURE SENSOR (CTS) RESISTANCE VALUES

Degrees °F	Degrees °C	Resistance (Ohms)
-40	-40	100,700
0	-18	25,000
20	-7	13,500
40	4	7,500
70	20	3,400
100	38	1,600
160	70	450
212	100	185

3) If any resistance is not within the range as specified in the table, replace the coolant temperature sensor.

4) Test the resistance of the wire harness between the ECU wire harness connector terminal "D-3" and the sensor connector terminal "C-10".

5) Repair any open circuits.

MANIFOLD AIR TEMPERATURE (MAT) SENSOR TEST

1) Disconnect the MAT wire harness connector from the MAT sensor. See Fig. 14*.

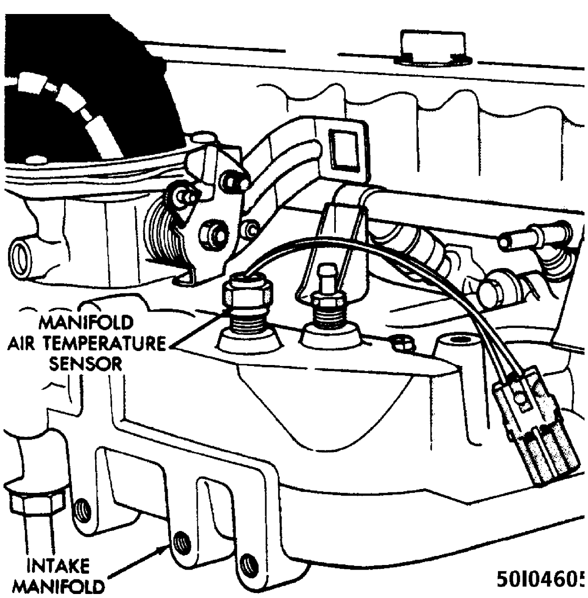


Fig. 14: Location of Manifold Air Temperature (MAT) Sensor
Courtesy of Chrysler Motors.

2) Using a high input impedance (digital) volt-ohmmeter, test the resistance of the sensor. Resistance should be less than 1000 ohms

with a warm engine. See the MANIFOLD AIR/FUEL TEMPERATURE (MAT) SENSOR RESISTANCE VALUES table below.

MANIFOLD AIR/FUEL TEMPERATURE (MAT)
SENSOR RESISTANCE VALUES

Degrees °F	Degrees °C	Resistance (Ohms)
-40	-40	100,700
0	-18	25,000
20	-7	13,500
40	4	7,500
70	20	3,400
100	38	1,600
160	70	450
212	100	185

3) If any resistance is not within the range as specified in the table, replace the MAT sensor.

4) Test the resistance of the wire harness between the ECU wire harness connector terminal "D-3" and the sensor connector terminal "C-8".

5) Repair as necessary any circuits displaying a value greater than one ohm.

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR TEST

1) Inspect the MAP sensor vacuum hose connections at the throttle body and the MAP sensor. See Fig. 15. Repair vacuum hose or connections as necessary.

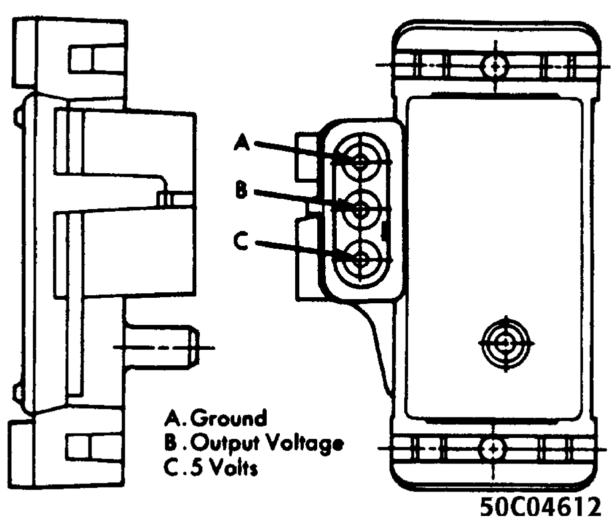


Fig. 15: Manifold Absolute Pressure (MAP) Sensor Connectors
Courtesy of Chrysler Motors.

2) With the ignition switch ON and engine OFF, test the MAP sensor output voltage at the MAP sensor connector terminal "B". See

Fig. 15. With a hot idle condition, the voltage reading should drop to between 0.5-1.5 volts.

3) Test ECU terminal "C-6" for the same voltage as described in step 2) to verify the wiring harness. Repair as necessary.

4) Test the MAP sensor supply voltage at the sensor connector terminal "C" with the ignition ON. Voltage reading should be between 4.5-5.5 volts. Check that the voltage reading at terminal "C-14" is also 4.5-5.5 volts.

5) Repair or replace the wire harness as necessary.

6) Test the MAP sensor ground circuit at the sensor connector terminal "A" and ECU connector terminal "D-3". Repair the wire harness as necessary.

7) Using an ohmmeter, test the MAP sensor ground circuit at the ECU connector between terminal "D-3" and terminal "B-ll". If an open circuit is indicated, check for a defective sensor ground connection. The MAP sensor ground is located on the right side of the engine block.

8) If, after performing step 7), the ground connection is verified to be good, check for a short to 12 volts at terminal "D-3". If a short is found, repair the short and then replace the ECU.

KNOCK SENSOR TEST

1) Connect Diagnostic Tester M.S. 1700 to the vehicle.

2) Go to "State Display" mode.

3) Start the engine and let idle.

4) Observe knock sensor value.

5) Using the tip of a screwdriver, lightly tap the cylinder block near the sensor while observing the knock sensor value.

6) The knock sensor value should increase when the cylinder block is tapped.

7) If the knock sensor value does not increase while tapping on the cylinder block near the knock sensor, check for proper connections to the knock sensor. If connections are good, replace the knock sensor. Refer to REMOVAL & INSTALLATION in this article.

ENGINE SPEED SENSOR TEST

1) Disconnect the engine speed sensor connector from the ignition control module.

2) place an ohmmeter between terminals "A" and "B" (marked on the connector). On a hot engine, the resistance reading should be between 125-275 ohms.

3) Replace sensor if readings are not within specification.

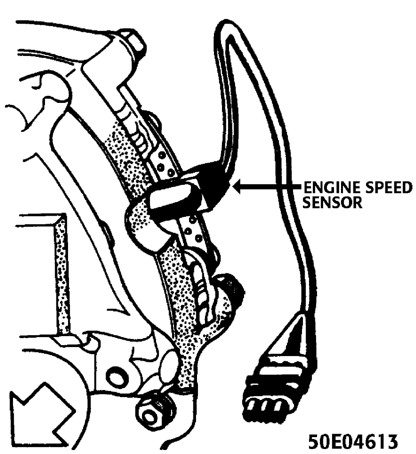


Fig. 16: View of Engine Speed Sensor Connectors (At Sensor)
Courtesy of Chrysler Motors.

SPARK PLUG CHECK

Faulty or fouled plugs may perform well at idle speed, but at higher engine speeds, they frequently fail. Faulty plug can exhibit the following symptoms:

* Poor fuel economy.
* Power loss.
* Decreased engine speed.
* Hard starting.
* Generally poor performance.

Spark plugs also malfunction due to carbon fouling, excessive electrode air gap, or broken insulators.

SYNC PULSE SIGNAL GENERATOR (STATOR) TEST

NOTE: For this test, an analog voltmeter MUST be used.

1) Insert the positive (+) lead of the voltmeter into the Blue wire at the distributor connector.
2) Insert the negative (-) voltmeter lead into the Gray/White wire at the distributor connector.

CAUTION: DO NOT remove the distributor connector from distributor. Insert the voltmeter leads into the backside of the distributor connector to make contact with the terminals.

3) Set the voltmeter to the 15-Volt D/C scale. Turn ignition key to "ON".
4) The voltmeter should display approximately 5.0 volts.
5) If no voltage displays, check that the voltmeter leads are making good contact. If there is still no voltage, go to next step.
6) Remove the ECU and check for voltage at pin "C-16" and ground with harness connected. If there in still no voltage, proceed to the next step.
7) Connect Diagnostic Tester M.S. 1700 to the vehicle. Using the diagnostic tester, perform vehicle test. If voltage is present, go to the next step.
8) Check for continuity between the Blue wire at the distributor connector and pin C-16 at the ECU.
9) If there in no continuity, repair harness as necessary.
10) Check for continuity between the Gray/White wire at the distributor connector and pin C-5 at the ECU.
11) If there is no continuity, repair harness as necessary.
12) Check for continuity between the Black wire at the distributor connector and ground.
13) If there is no continuity, repair harness as necessary.
14) While observing the voltmeter, crank the engine; the voltmeter needle should fluctuate back and forth while the engine in cranking. A fluctuation verifies that the stator in the distributor is operating properly.
15) If there is no pulse sync, replace the stator. Refer to REMOVAL & INSTALLATION below in this article.

REMOVAL & INSTALLATION

COOLANT TEMPERATURE SENSOR (CTS)

Removal
1) Drain the cooling system.

2) Remove air cleaner assembly.
3) Disconnect the CTS wire connector. See Fig. 17.
4) Remove the CTS from the left side of the engine block.

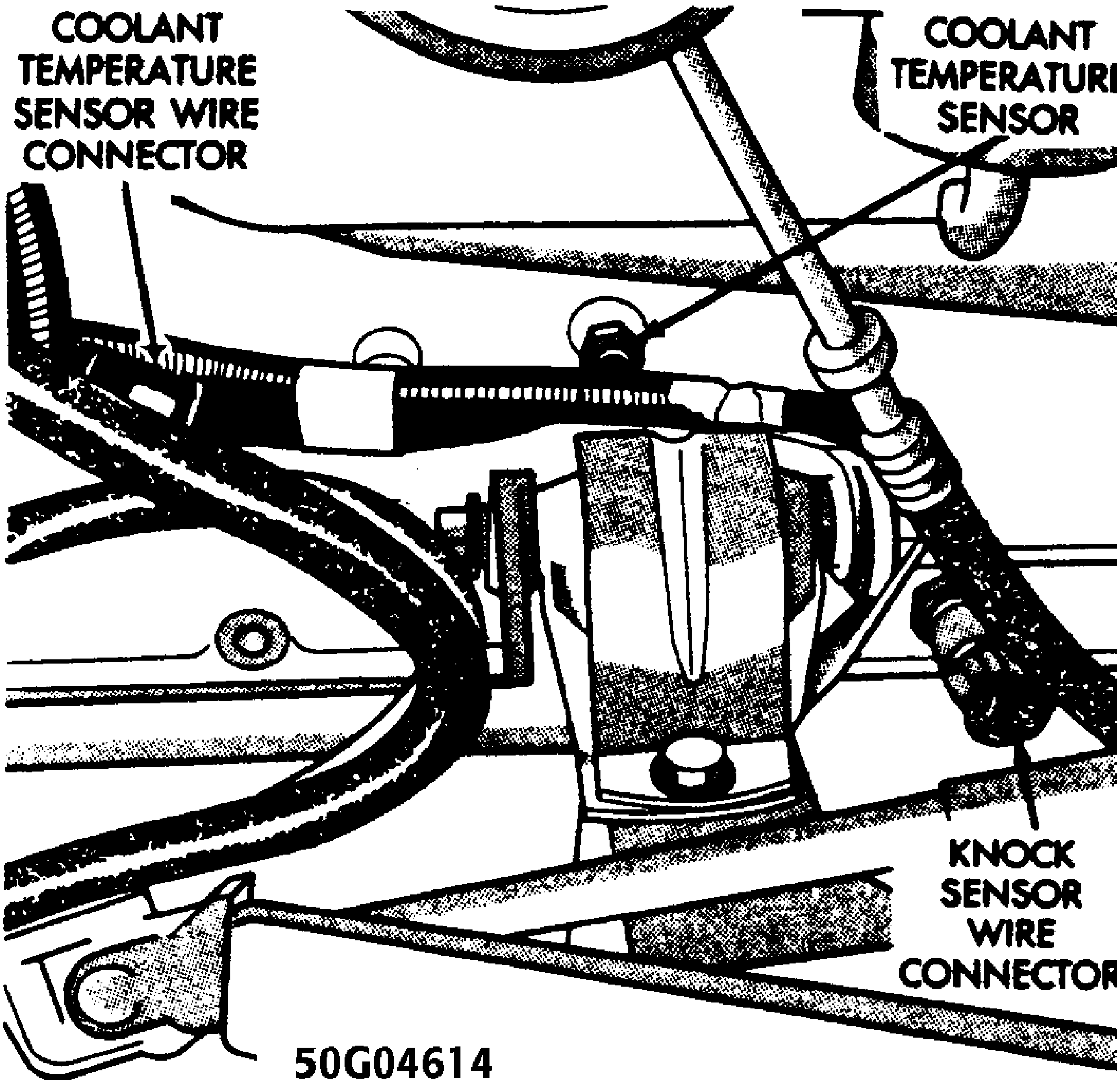


Fig. 17: Coolant Temperature Sensor (CTS) Connector
Courtesy of Chrysler Motors.

Installation

1) Install the CTS to the cylinder block. Tighten the CTS to 21 Ft. Lbs. (28 Nm).
2) Connect the CTS wire connector.
3) Install air cleaner assembly.
4) Fill the cooling system.

MANIFOLD AIR TEMPERATURE (MAT) SENSOR

Removal

1) Disconnect the MAT sensor wire connector. See Fig. 18.

2) Remove the MAT from the intake manifold.

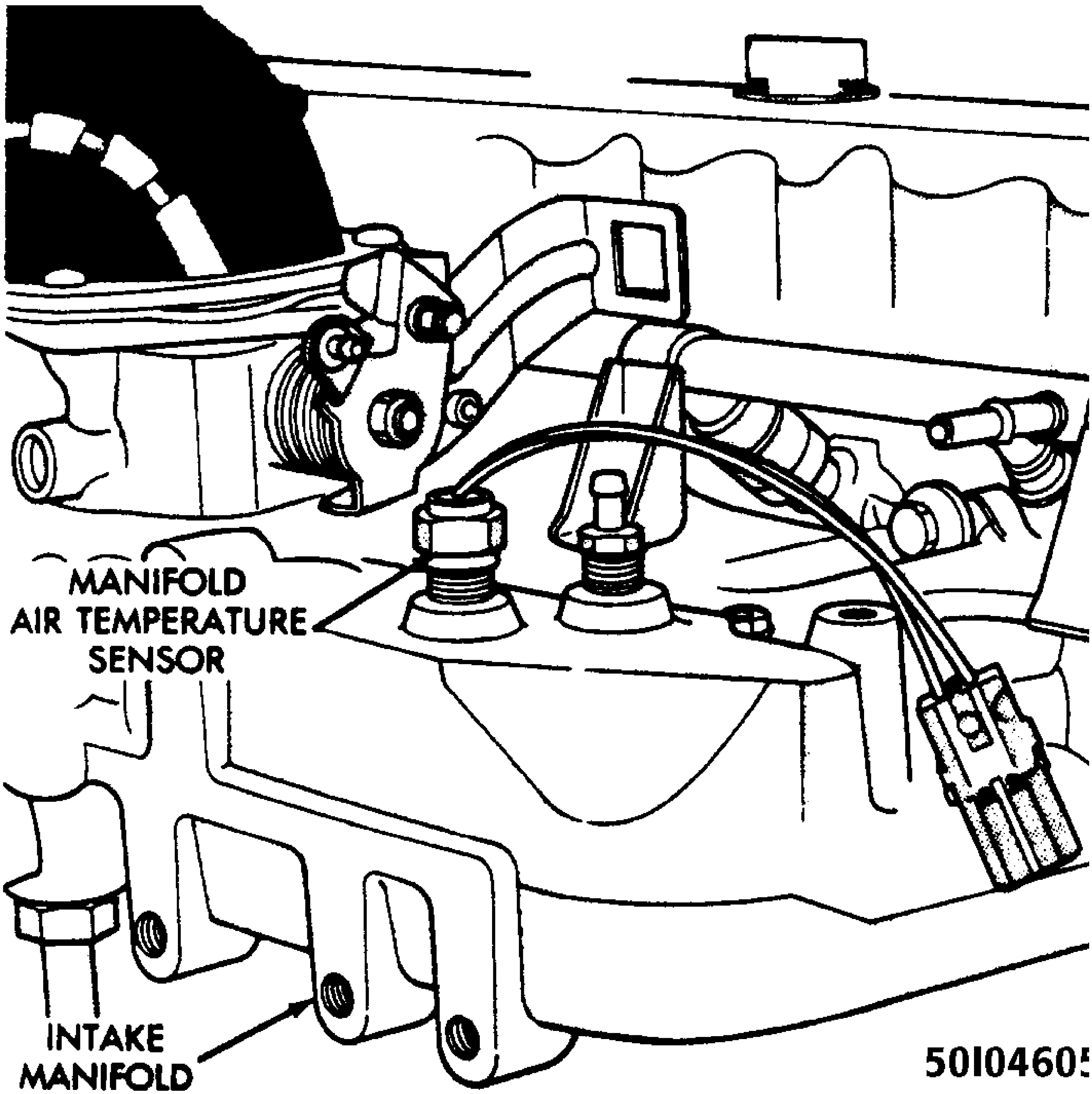


Fig. 18: Manifold Air Temperature (MAT) Sensor Connectors
Courtesy of Chrysler Motors.

Installation

1) Install the MAT sensor to the cylinder block. Tighten the MAT sensor to 21 Ft. Lbs. (28 Nm).

2) Connect the MAT sensor wire connector.

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR

Removal

1) Disconnect the MAP sensor wire connector. See Fig. 19.

2) Disconnect MAP sensor vacuum supply hose from MAP sensor.

3) Remove the MAP sensor attaching nuts. Remove MAP sensor from the firewall.

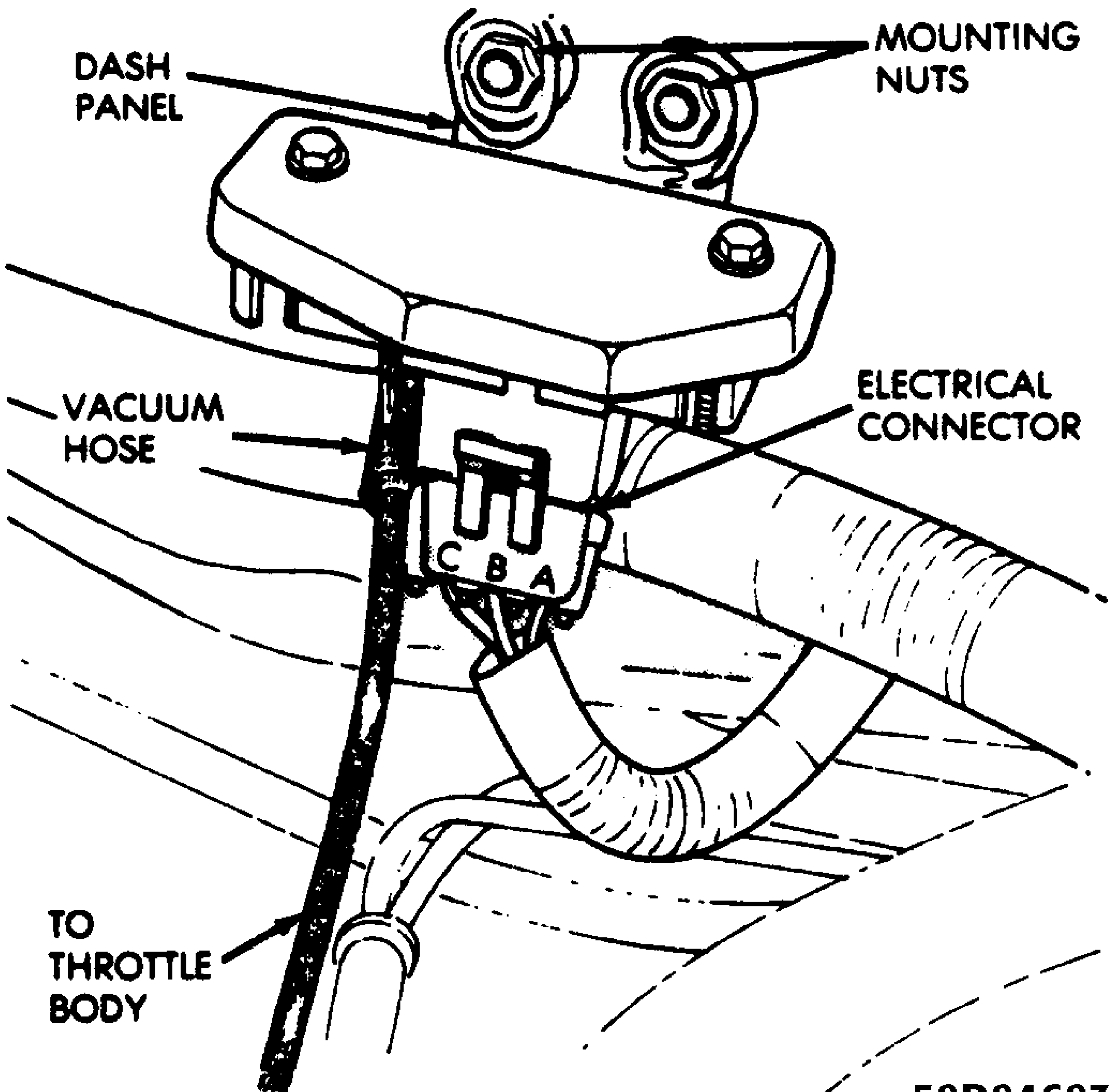


Fig. 19: View of Manifold Absolute Pressure (MAP) Sensor Mounting Nuts & Vacuum Supply Hose
Courtesy of Chrysler Motors.

Installation

1) Install the MAP sensor to the firewall. Tighten the MAP sensor attaching nuts.

2) Connect the MAP sensor vacuum supply hose.

3) Connect the MAP sensor wire connector.

KNOCK SENSOR

Removal

1) Raise and support the vehicle.

2) Disconnect the knock sensor wire connector located below and to the rear of the Coolant Temperature Sensor. See Fig. 20.

3) Remove knock sensor from left side of the engine block.

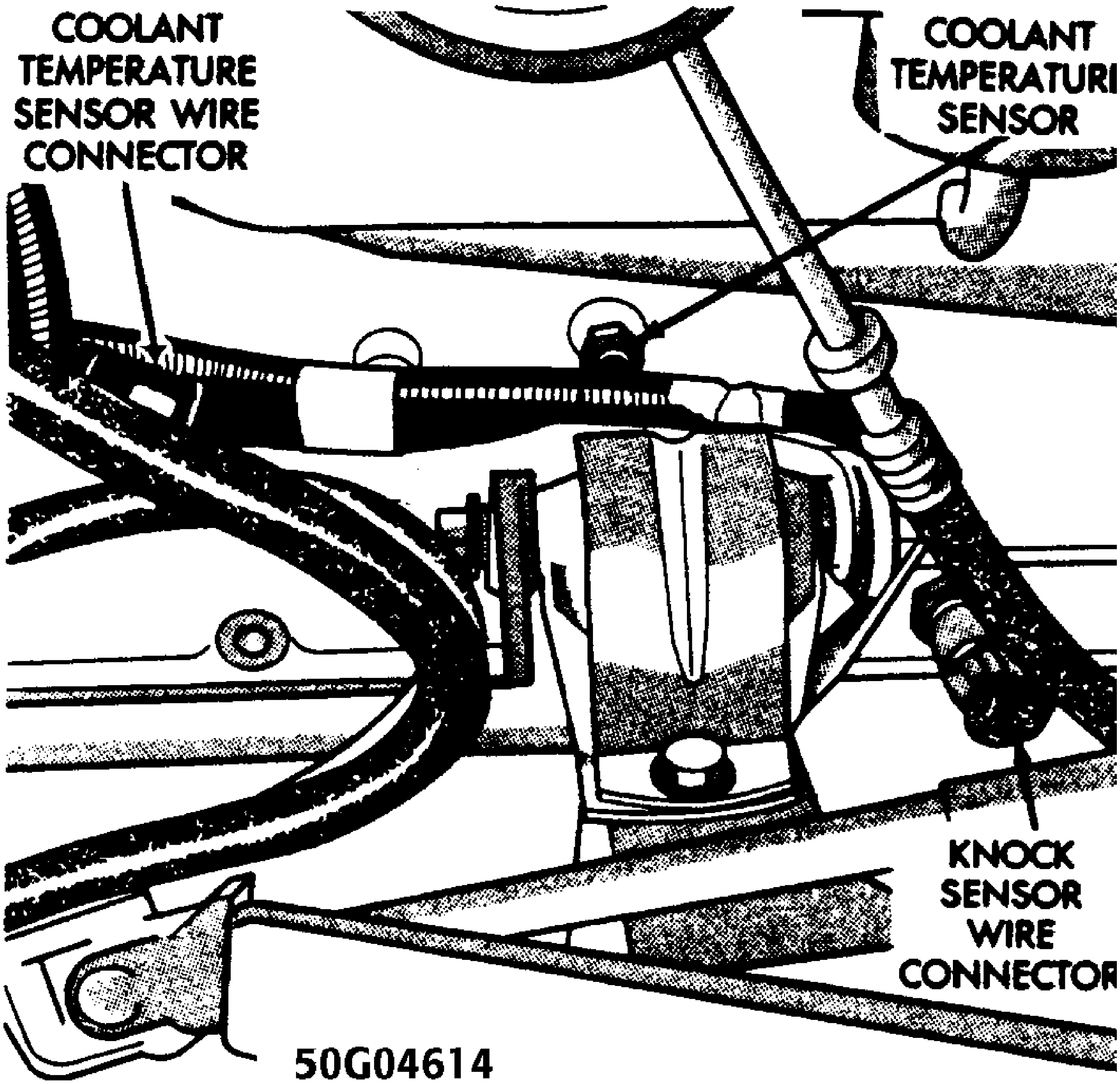


Fig. 20: Knock Sensor Connector
Courtesy of Chrysler Motors.

Installation

WARNING: The knock sensor MUST be tightened to the EXACT torque specified in order to ensure proper operation.

1) Install the knock sensor to the cylinder block. Tighten the knock sensor to 89 INCH Lbs. (10 Nm).
2) Connect the knock sensor wire connector.
3) Lower vehicle.

ENGINE SPEED SENSOR

Removal
1) Remove engine speed sensor wire connector. See Fig. 21.
2) Remove the engine speed sensor-to-transmission housing attaching bolts. Remove engine speed sensor from transmission housing.

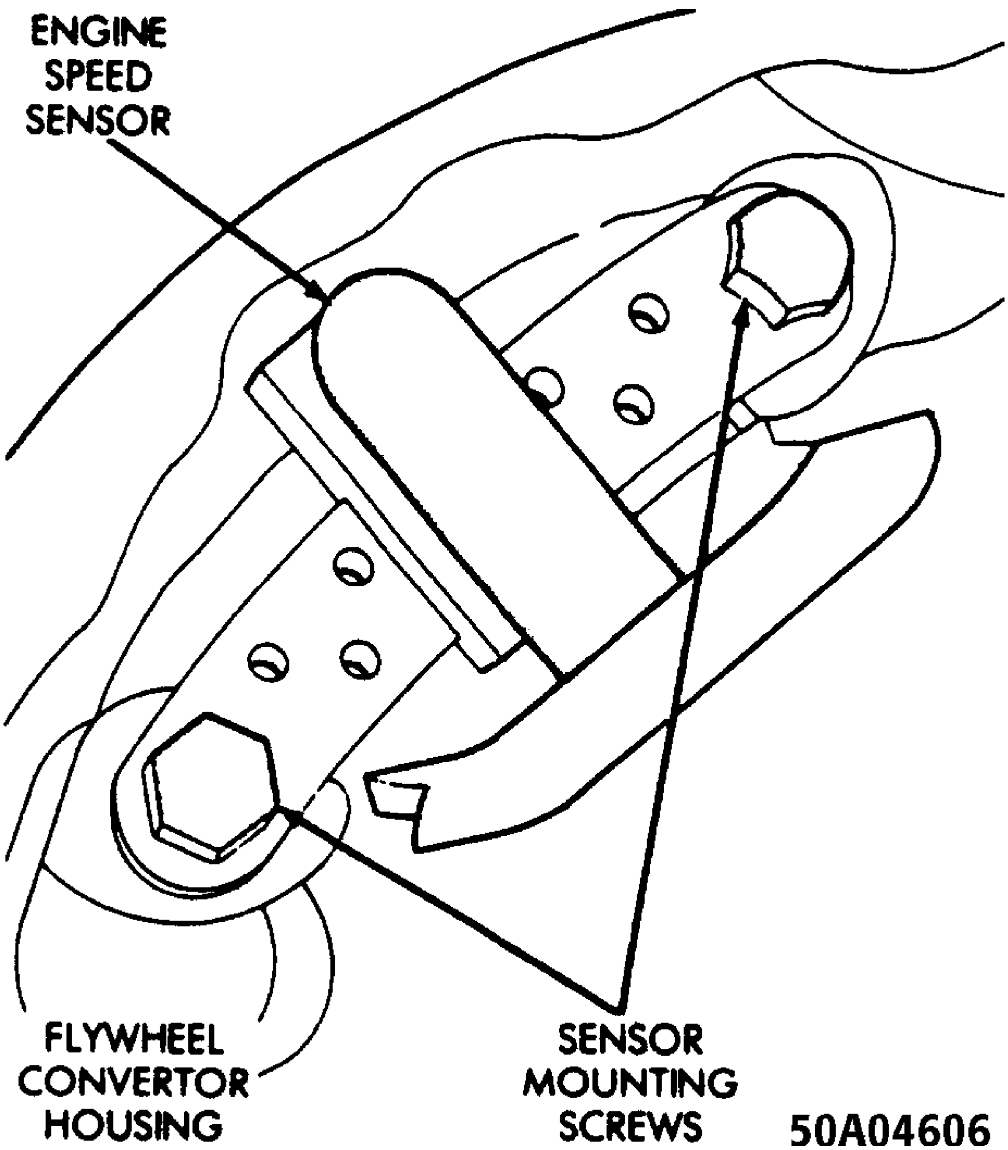


Fig. 21: Engine Speed Sensor Mounting Bolts
Courtesy of Chrysler Motors.

Installation
1) Install the engine speed sensor to the transmission

housing with 2 shoulder bolts. Tighten the engine speed sensor shoulder bolts.

2) Connect the engine speed sensor wire connector.

ELECTRONIC CONTROL UNIT (ECU)

Removal

NOTE: The ECU is located below the instrument panel, between the steering column and the A/C-Heater housing. See Fig. 22. Three screws mount the ECU to a bracket.

1) Disconnect the negative battery cable.
2) Remove the 3 ECU attaching screws. See Fig. 23.
3) Disconnect the ECU wiring harness connector.
4) Remove the ECU.

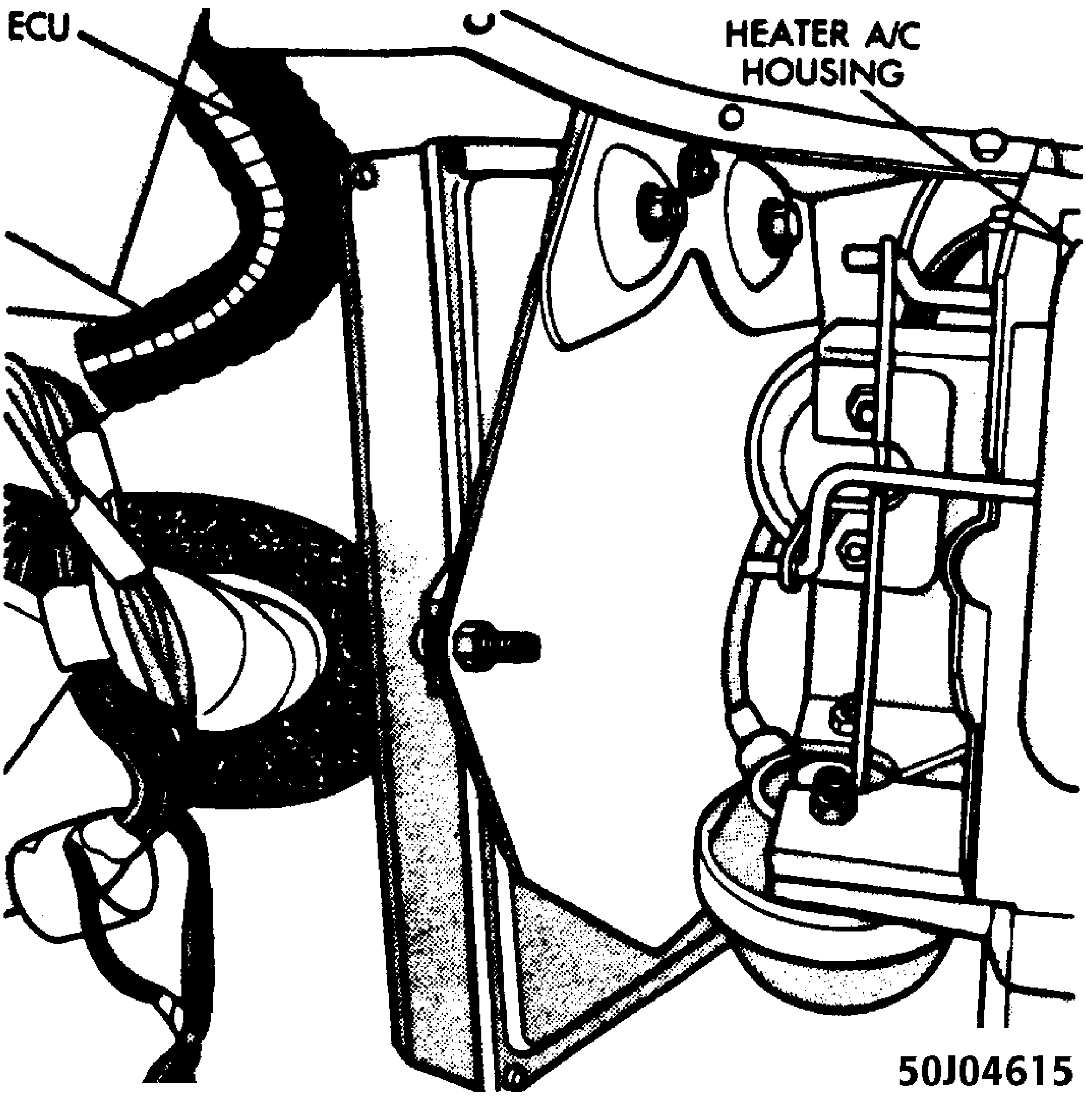


Fig. 22: Location of ECU
Courtesy of Chrysler Motors.

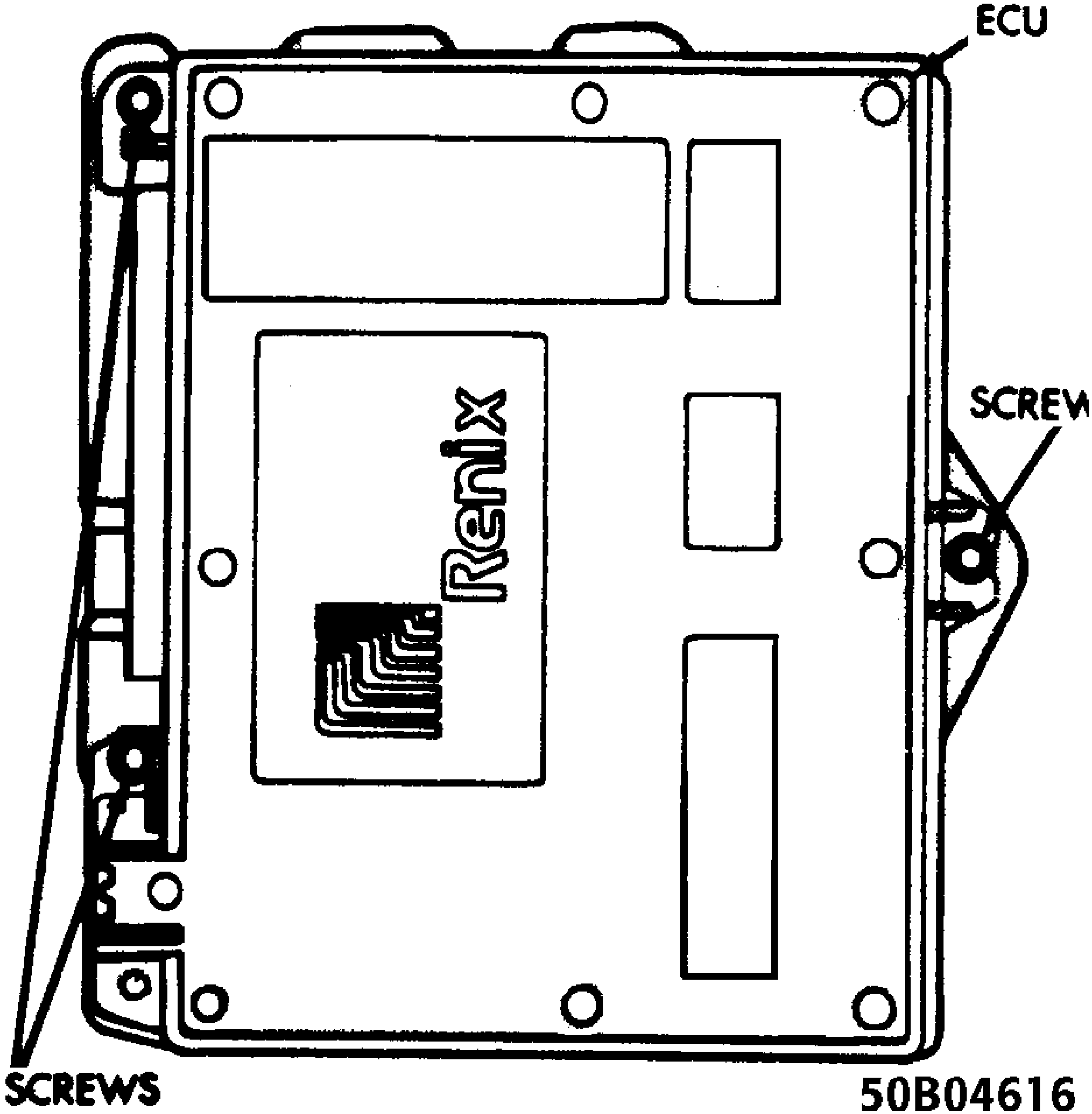


Fig. 23: Location of ECU Mounting Screws
Courtesy of Chrysler Motors.

Installation

1) Connect the ECU wiring harness connector.

2) While holding the ECU in position, attach the 3 ECU attaching screws. See Fig. 23.

3 Connect the negative battery cable.

DISTRIBUTOR

Removal

1) Disconnect the battery negative cable.

2) On vehicles equipped with A/C, remove the electrical cooling fan and shroud assembly from the radiator to allow room to rotate the engine with a socket and ratchet using the vibration damper bolt.

3) Scribe a mark on the distributor housing below the left side (past) the number one spark plug wire post of the distributor cap for reassembly reference for No 1 cylinder firing position.

4) Remove the distributor cap.

5) Turn the engine in a clockwise direction until the rotor is approaching the scribed mark on the distributor housing. Then slowly turn the engine until the timing mark on the crankshaft vibration damper lines up with zero on the front cover timing scale. See Fig. 24.

NOTE: The timing mark is located on the edge of the vibration damper closest to the front cover.

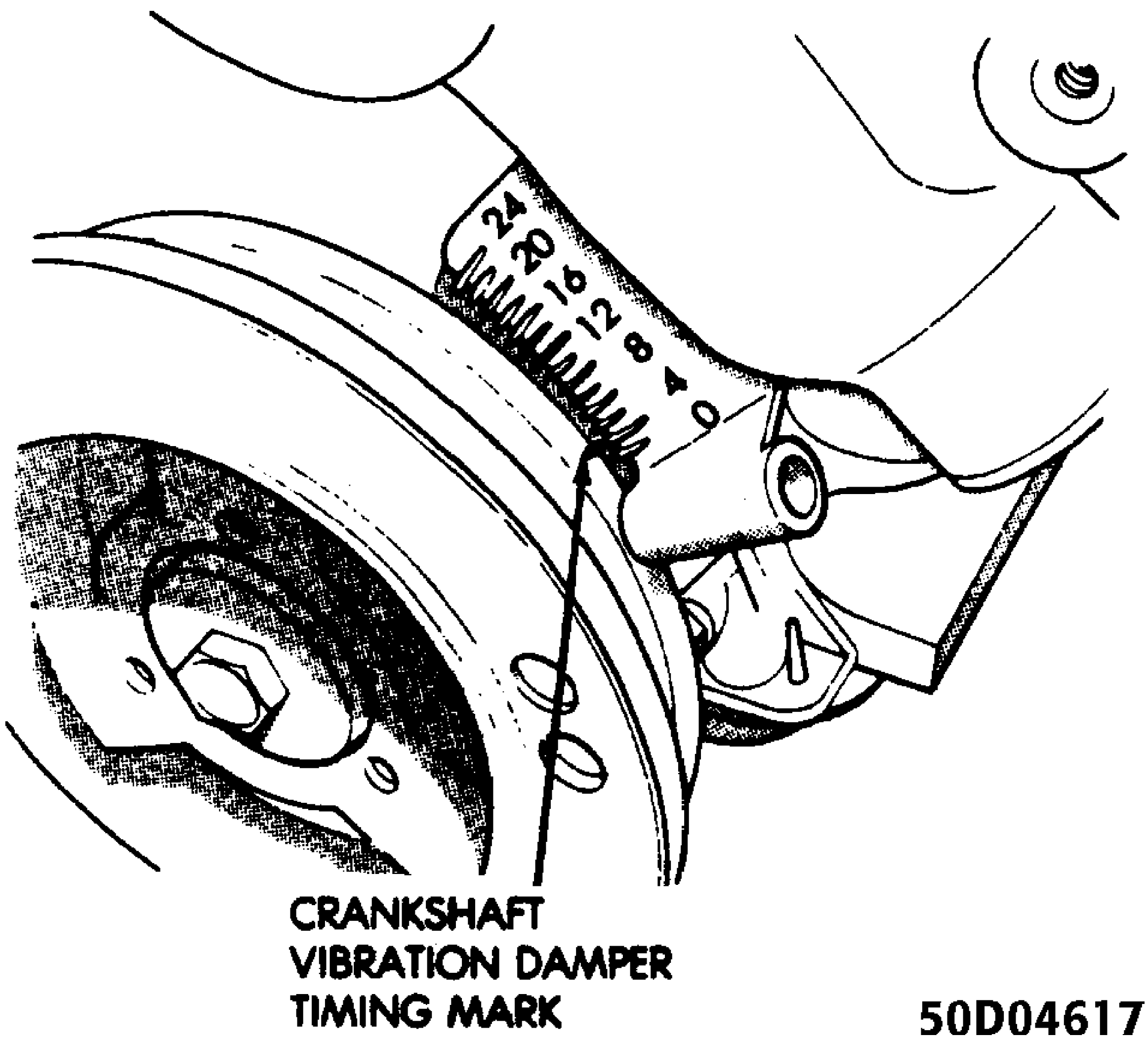


Fig. 24: View of Crankshaft Vibration Damper Timing Marks
Courtesy of Chrysler Motors.

6) Align the trailing edge of the rotor blade with the mark previously scribed on the distributor housing. See Fig. 25.

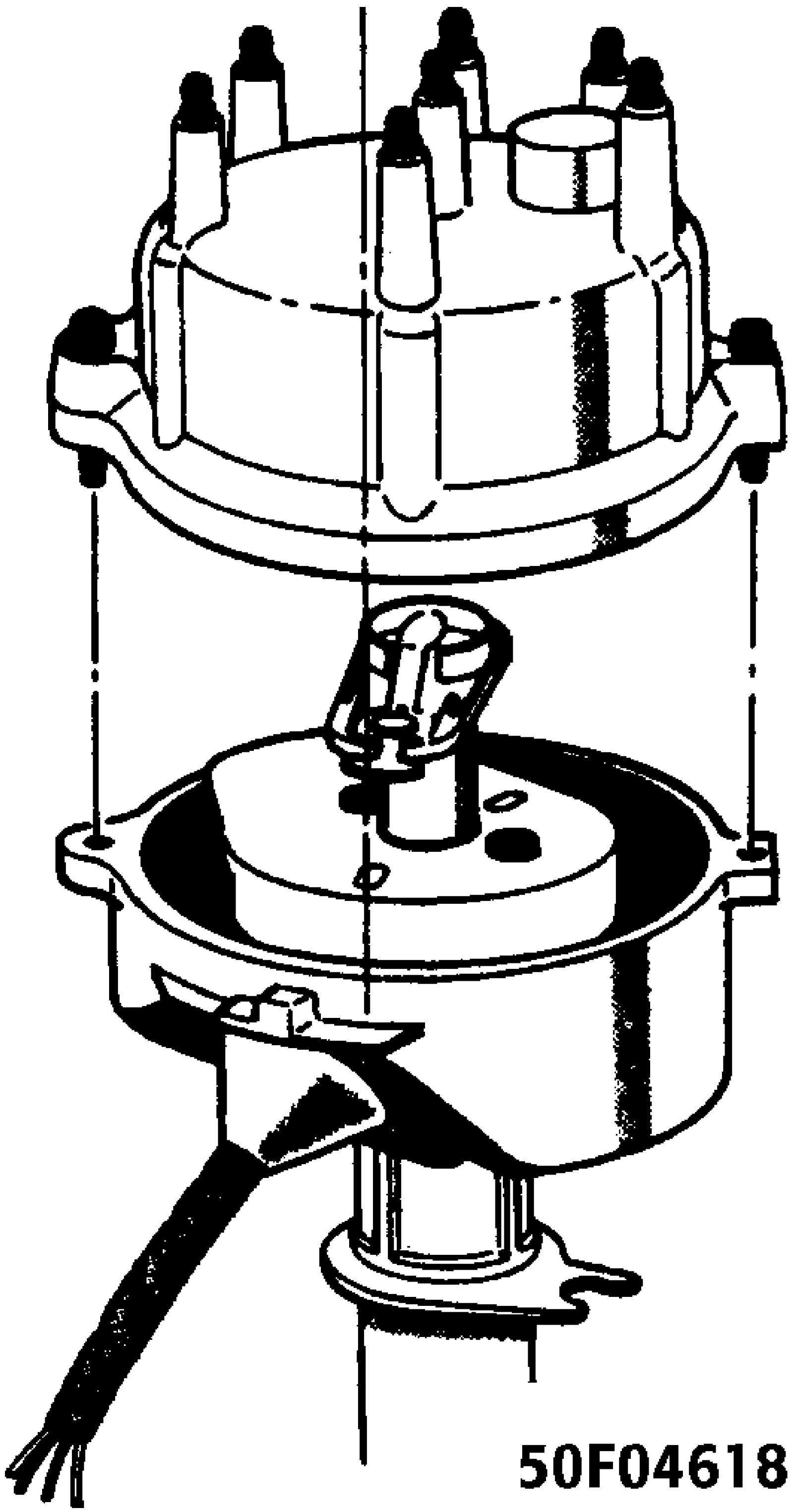


Fig. 25: Aligning Rotor & Distributor Cap for Removal
Courtesy of Chrysler Motors.

7) Remove the distributor hold-down bolt and clamp.
8) Remove the distributor from the engine.

Installation

1) If needed, use a flat blade screwdriver to turn the oil pump gear shaft until the slot is slightly past the 11 o'clock position. See Fig. 26. The oil pump shaft is located down in the distributor hole.

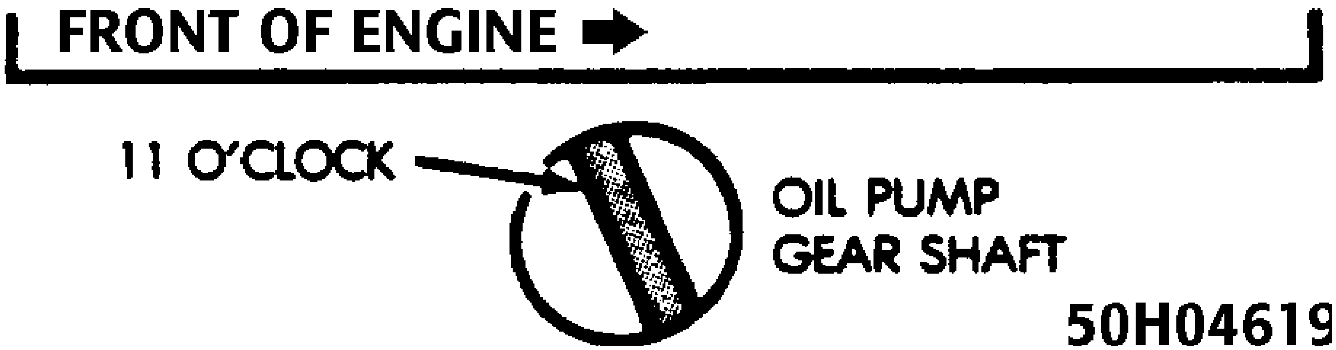


Fig. 26: Aligning Oil Pump Gear Shaft
Courtesy of Chrysler Motors.

2) Install the rotor.

3) Without engaging the distributor gear into the cam gear and ensuring the distributor gasket is installed, position the distributor into the hole in the engine block.

4) Visually line up the hold down ear of the distributor housing with the hold down clamp hole. See Fig. 27.

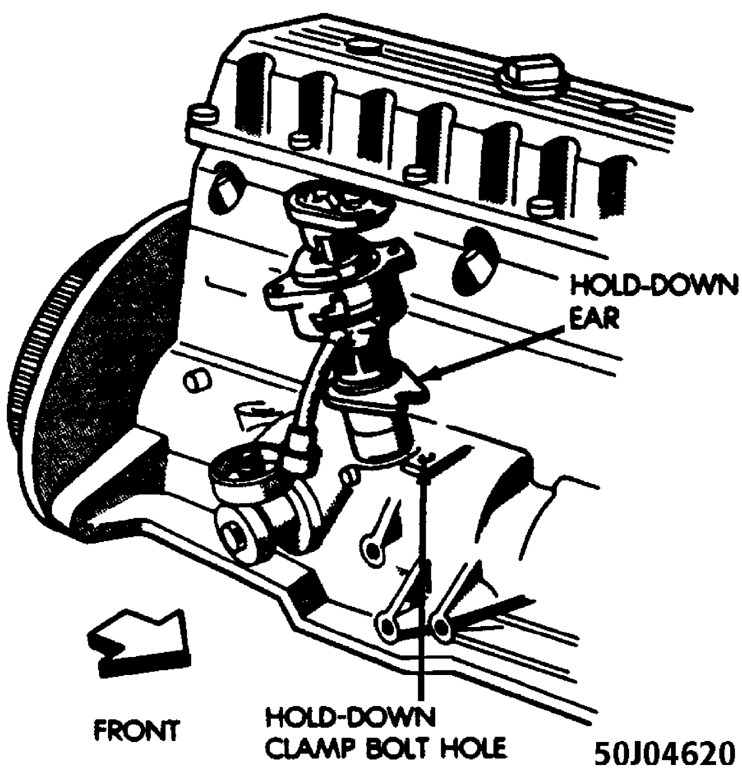


Fig. 27: Installing Distributor
Courtesy of Chrysler Motors.

5) Turn the rotor to the 4 o'clock position. See Fig. 28.

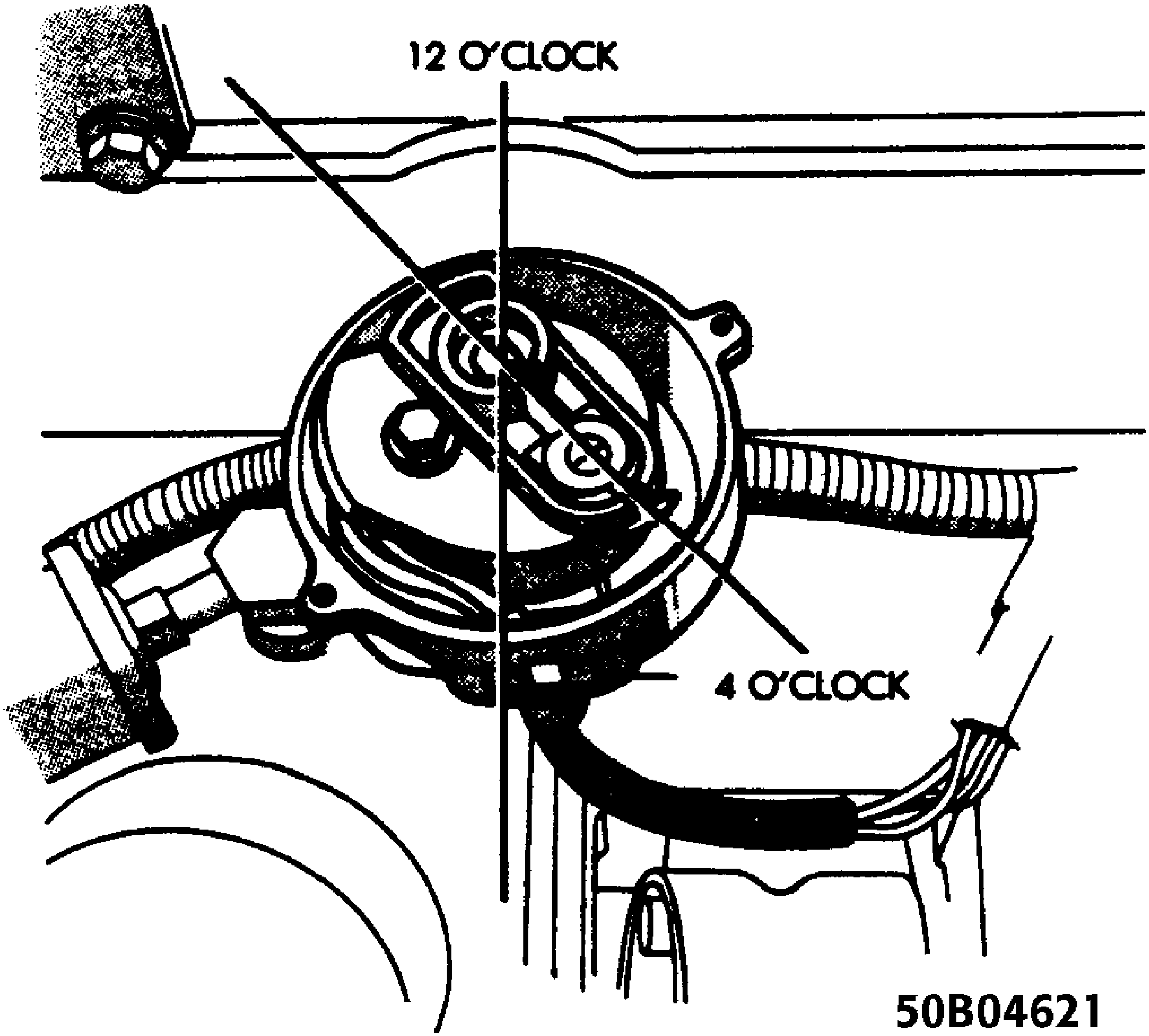


Fig. 28: Installing & Aligning Rotor
Courtesy of Chrysler Motors.

6) Carefully slide the distributor into the block until it seats, keeping the hold down ear aligned to the hole in the block.

7) The rotor should be in the 5 o'clock position with the trailing edge of the rotor blade lined up with the mark previously scribed on the distributor housing (number one spark plug wire post location).

8) install the distributor hold-down clamp bolt and tighten to 9.5-14 Ft. Lbs. (13-19 N.m).

9) Install the distributor cap. Connect the distributor electrical connector.

10) Install the electric cooling fan and shroud if applicable.

11) Connect the negative battery cable.

IGNITION/COIL WIRE REPLACEMENT PRECAUTIONS

Removal & Installation

Using care, disconnect the spark plug and coil wire boots and wires. Twist the boot one half turn and pull on the boot to disconnect the wire.

When replacing the spark plug and coil wires, carefully route the wires correctly and secure them in their proper channels retainers.

Failure to route the wires properly can cause the radio to reproduce ignition noise, cross ignition of the plugs, or can short circuit the wires to ground.

OVERHAUL

STATOR REPLACEMENT

Disassembly

1) Remove the distributor as specified in DISTRIBUTOR under REMOVAL & INSTALLATION above in this article.

2) Remove the distributor rotor.

3) Position the distributor in a vise.

4) Remove the distributor gear from the shaft using a small punch and a hammer to drive out the retaining roll pin. See Fig. 29.

5) Remove the distributor shaft from the distributor housing.

6) Remove the stator retaining screw.

NOTE: Mark the location of the stator position for reassembly reference.

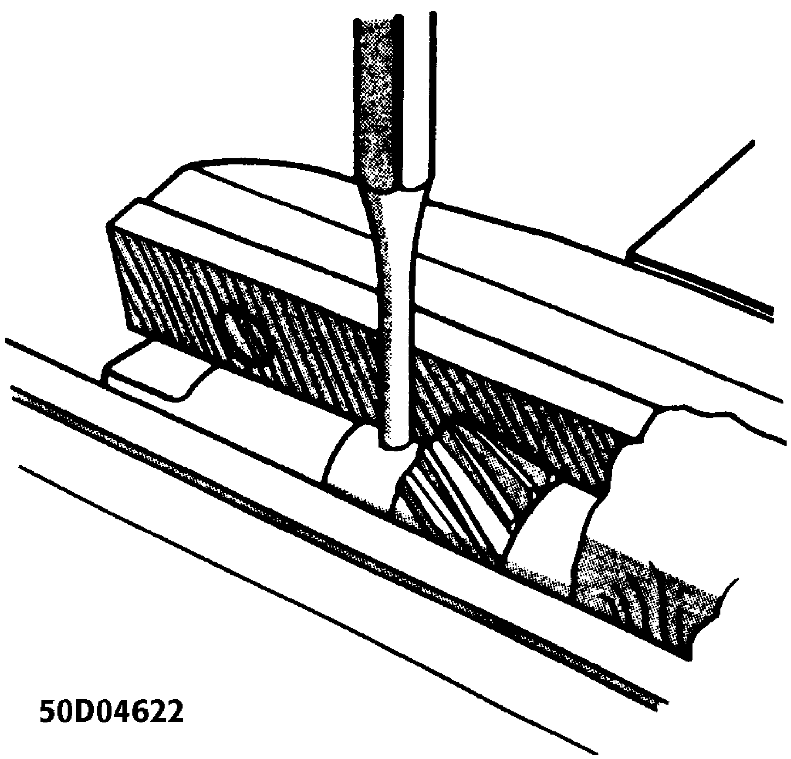


Fig. 29: Removing Distributor Gear Retaining Roll Pin
Courtesy of Chrysler Motors.

7) Remove stator harness by pushing the grommet through the distributor housing. Remove stator assembly. See Fig. 30.

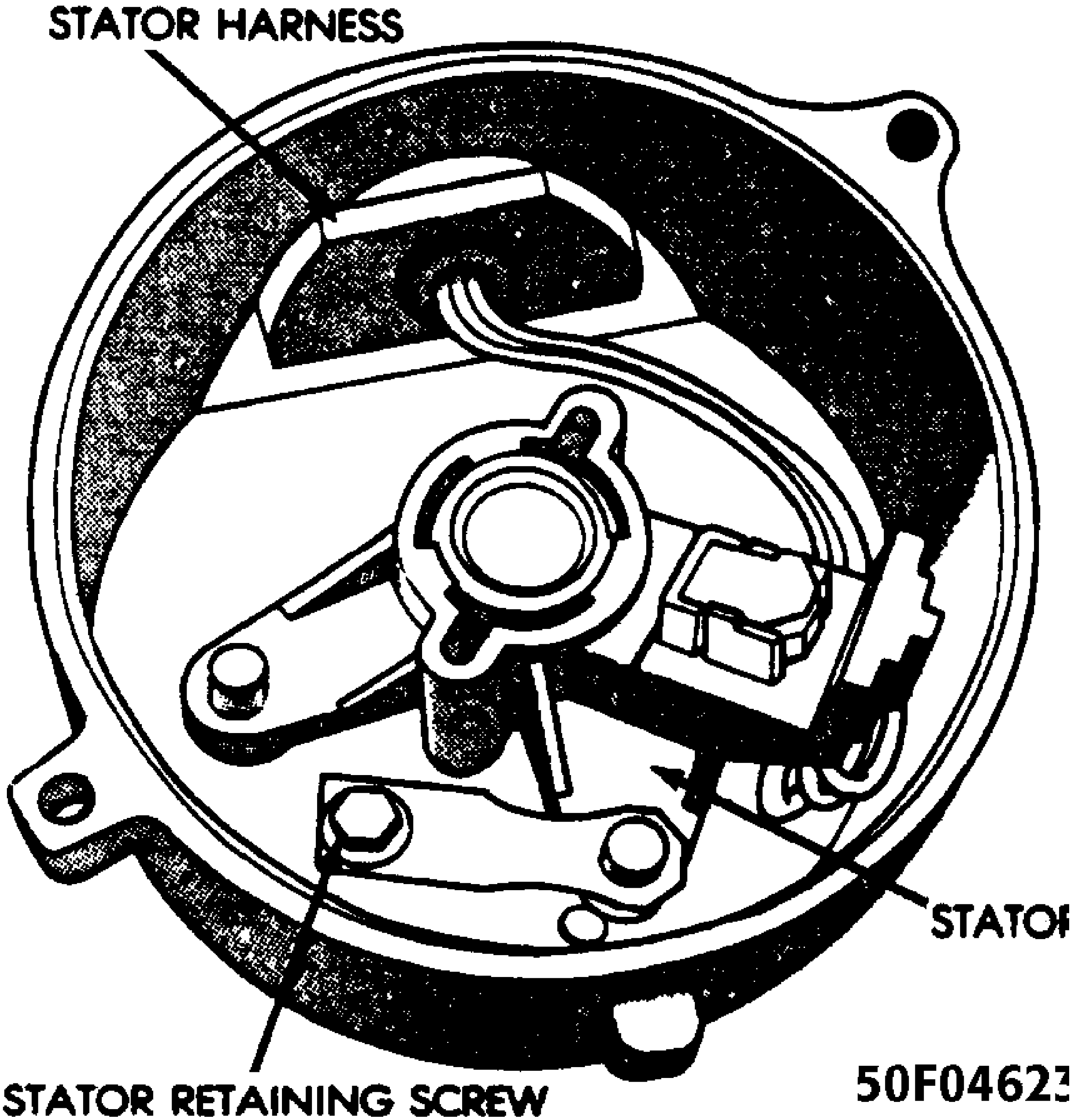


Fig. 30: Location of Stator Retaining Screw
Courtesy of Chrysler Motors.

Reassembly

1) Install stator assembly and the stator retaining screw.

2) Position the stator assembly harness through the distributor housing and push the grommet into position.

3) Install distributor shaft into the distributor housing. If the shaft is equipped with seals, ensure that they are in place and not damaged.

4) Install the distributor gear washer and distributor gear onto the shaft.

5) Install the distributor gear retaining pin.

6) Install the distributor rotor.

7) Install the distributor as specified in DISTRIBUTOR under REMOVAL & INSTALLATION above in this article.

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS

Application	Ft. Lbs. (N.m)
Coolant Temperature Sensor	21 (28)
Distributor Hold-Down Clamp Bolt	9.5-14 (13-19)
Manifold Air Temperature Sensor	21 (28)
	INCH Lbs. (N.m)
Knock Sensor	89 (10)

Distributors & Ignition Systems
HEI, HEI/EST & HEI/EST/ESC IGNITION SYSTEM

Jeep 4.0L

DESCRIPTION

HIGH ENERGY IGNITION (HEI)

The Delco-Remy High Energy Ignition system is a self-contained unit. It consists of ignition coil, spark plugs, distributor assembly and primary and secondary wiring. The distributor housing contains an electronic control module, pick-up coil, pole piece, timer core, rotor, capacitor for radio noise suppression and timing advance mechanisms. Most applications house the ignition coil assembly within the distributor cap. See Fig. 1.

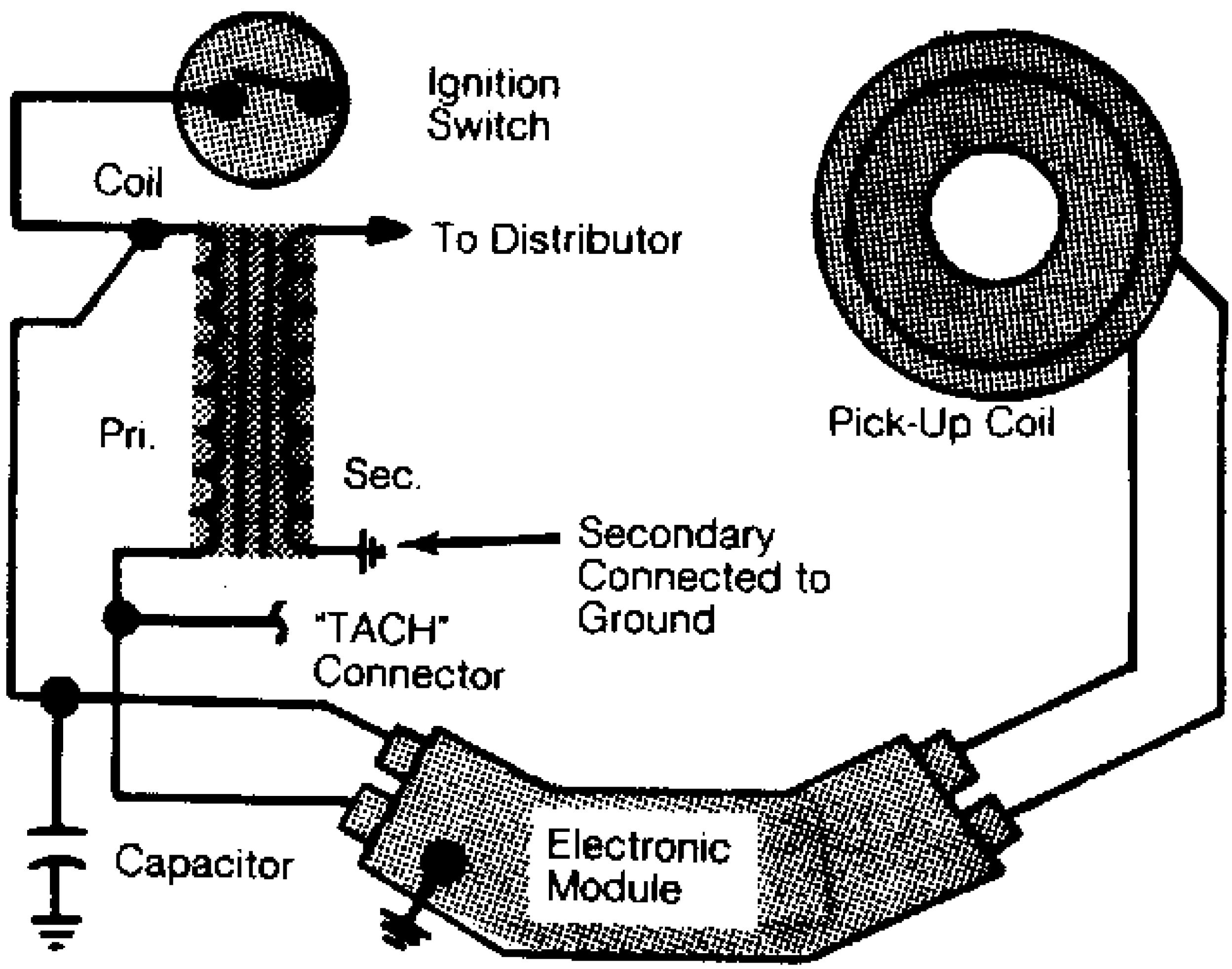


Fig. 1: Delco-Remy HEI System Circuit Diagram
Courtesy of General Motors Corp.

HEI WITH ELECTRONIC SPARK TIMING (EST)

Electronic Spark Timing (EST) is used on most computer controlled systems. The Electronic Control Module (ECM) monitors information from various engine sensors, computes desired spark timing, and signals distributor for correct timing change. The HEI distributor with EST does not have centrifugal advance weights, springs, or a vacuum advance unit. See Figs. 2 and 3.

HEI & EST WITH ELECTRONIC SPARK CONTROL (ESC)

All fuel injected vehicles are equipped with Electronic Spark Control (ESC). ESC systems contain a knock sensor mounted in the engine block. A Blue wire connects the sensor to the ESC module. If the sensor detects knock, it sends a signal to the module which, in turn, signals the ECM. The ECM sends a signal to the distributor to retard spark timing.

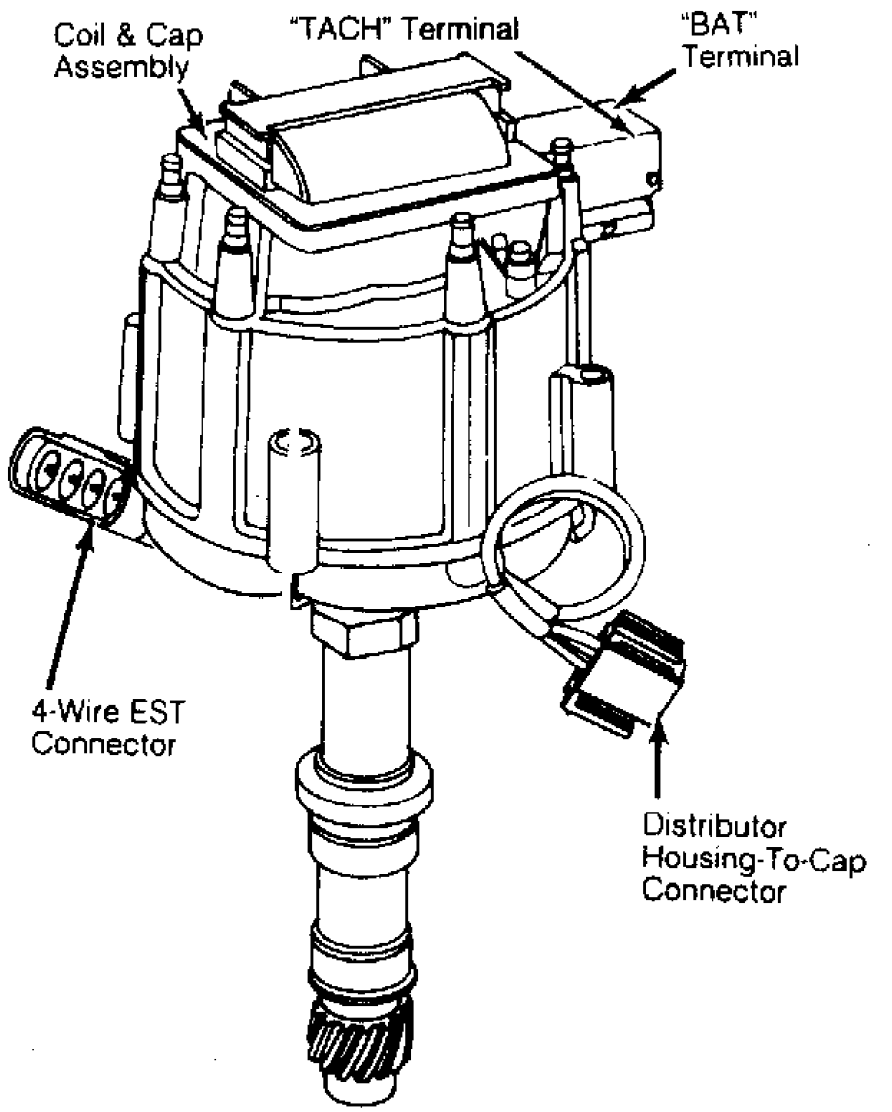


Fig. 2: Typical HEI/EST Distributor, Integral coil system shown. Courtesy of General Motors Corp.

OPERATION

IGNITION SYSTEM

When the external teeth on the timing core approach, align with and pass the internal teeth on pole piece, an alternating current is induced in the pick-up coil windings. This alternating current signals switching transistors in the HEI module to make or break the ignition coil primary ground circuit. When the primary ground circuit is removed, the magnetic field created by the flow of current in the primary windings collapses across the primary and secondary windings of the coil. This induces a high-voltage surge in the secondary windings of the coil. Secondary voltage is then discharged to the rotor which distributes it to the appropriate spark plug terminal. The distributor module has different terminal arrangements depending on application.

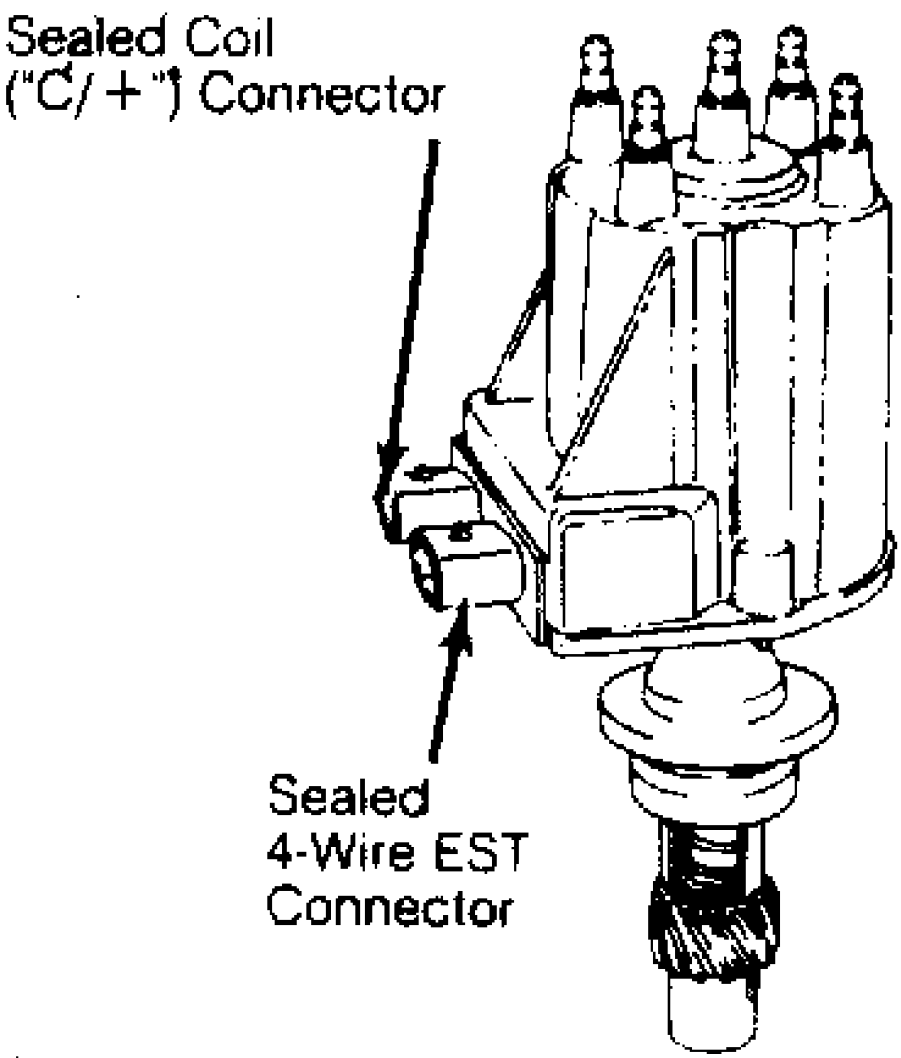


Fig. 3: HEI/EST Distributor w/Sealed Module Connectors, External coil system shown.
Courtesy of General Motors Corp.

EST SYSTEM

The ECM monitors information concerning crankshaft position, engine RPM, engine load, atmospheric conditions, engine temperature, and transmission gear position. This information is used by the ECM to compute desired spark timing which is relayed to the distributor, enabling appropriate changes to be made to ignition timing. A back-up spark advance system is incorporated to signal ignition module in the event of ECM failure.

CAUTION: Although similar in appearance, components of HEI/EST and HEI distributors are NOT interchangeable.

All Models With EST

The distributor module is connected to ECM by a 4-wire EST connector which performs the following functions:

* Terminal "A" of the 4-wire connector is the reference ground low. It is grounded in the distributor and ensures ground circuit does not have a voltage drop. If circuit is open, engine may experience poor performance.
* Terminal "B" of the 4-wire connector is the by-pass circuit. At about 400 RPM, ECM applies 5 volts to this circuit to switch spark timing control from module to ECM. An open or grounded by-pass circuit will set a code 42 and the engine will operate at base timing, plus a slight amount of advance built into the module.
* Terminal "C" is the distributor reference High circuit. This circuit provides the ECM with RPM and crankshaft position information.
* Terminal "D" is the EST circuit, which triggers the module. The ECM does not know what actual timing is, but does know when it receives the reference signal. It will advance or retard spark from that point. If base timing is set incorrectly, engine spark curve will be incorrect.

SENSORS

On EST systems, the coolant temperature sensor signals ECM to advance timing on a cold engine and return timing to programmed advance curve as engine reaches normal operating temperature. If engine overheats, spark is retarded to prevent detonation. During light throttle operation, throttle position sensor input to ECM allows for additional advance.

Spark advance is also governed by input from engine RPM and Manifold Absolute Pressure (MAP) sensor. When MAP output voltage is low (high vacuum), ECM gives less spark advance. More spark advance is given when MAP output voltage is high (low vacuum).

ELECTRONIC SPARK CONTROL (ESC) SYSTEM

All Fuel Injected Engines

The basic components of Electronic Spark Control (ESC) system are detonation (knock) sensor, HEI/EST distributor, ESC module and ECM. When detonation (knock) occurs, sensor sends an electrical signal to ESC module. The ESC module then sends the signal voltage to the ECM. When the ECM senses a voltage drop (to less than one volt) on the knock sensor signal line, spark timing will be retarded. The ECM will retard spark timing until all signals from detonation sensor cease. See Fig. 4.

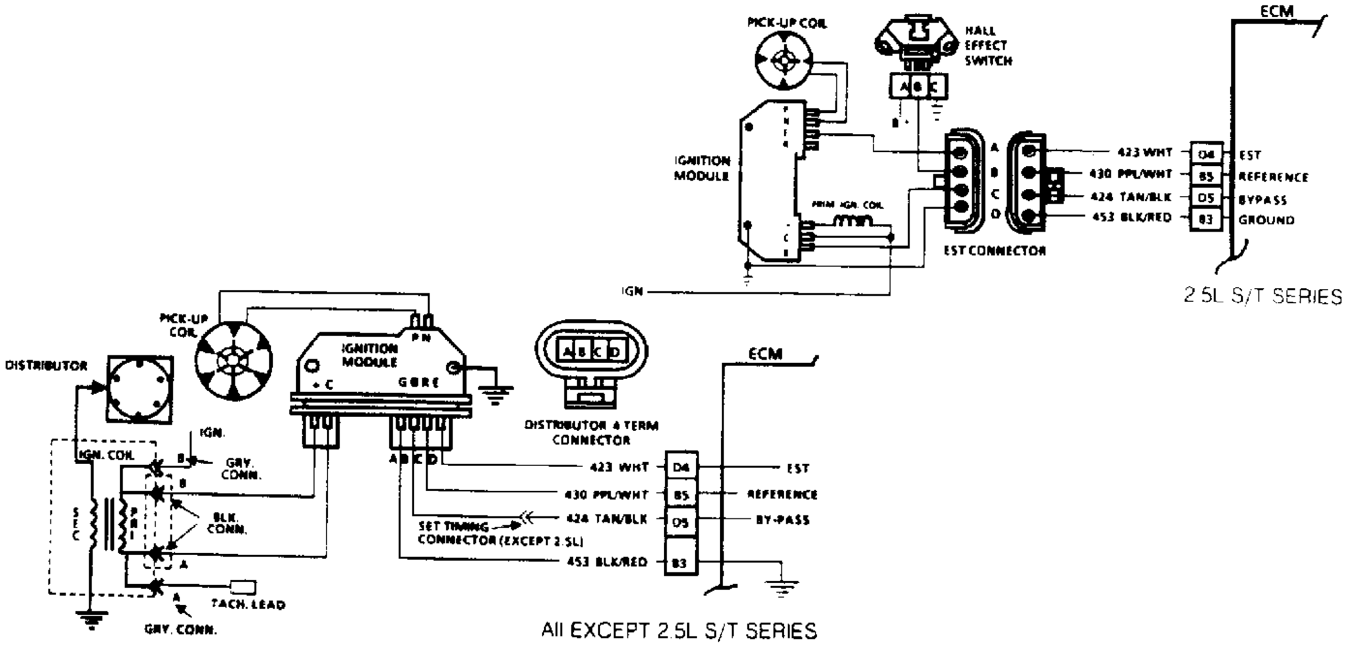


Fig. 4: Circuit Diagram of HEI/EST Ignition System
Courtesy of General Motors Corp.

ADJUSTMENTS

The only adjustments that can be made to HEI/EST igntion system are basic ignition timing and spark plug gap.

DIAGNOSIS

If reference or EST signals are interrupted due to an open circuit or a faulty ECM, HEI/EST module will provide a timing signal based on engine RPM. Engine may continue to run, although less efficiently. If by-pass signal is lost, by-pass switch will direct RPM information directly to coil rather than to ECM.

Normally, 5-15 seconds after starting a warm engine, by-pass signal from ECM will operate a by-pass switch in HEI/EST module. The HEI/EST module's RPM-controlled timing signal will switch over and RPM signal will flow directly to the ECM for processing.

Loss of EST signal from ECM when 5-volt by-pass signal is present will cause engine to stop because HEI/EST module is no longer sending signals directly to ignition coil. Any loss of EST signal will stop all flow to coil. If vehicle is restarted, engine will run for a few seconds and stop when by-pass signal comes back on.

COMPONENT TESTING (HEI)

ELECTRONIC MODULE

NOTE: Testing applies to HEI systems with mechanical weights and vacuum advance only.

1) An approved electronic module tester must be used to test the module. Use Module Tester (J-24642-E). Follow manufacturer's instructions.

2) When installing a new HEI control module, use silicone

lubricant on module-to-distributor housing contact surface to assist heat dispersement.

IGNITION COIL

1) Connect an ohmmeter between the negative terminal and the high voltage terminal. See Fig. 5. Use high resistance scale. If ohmmeter does not indicate below infinite resistance, coil must be replaced.

2) Connect ohmmeter between the positive terminal and coil frame (ground). Use the high resistance scale. If ohmmeter does not indicate infinite resistance, replace coil.

3) Connect ohmmeter between positive and negative terminals. Use low resistance scale. Ohmmeter should indicate 0-1 ohm. If not, replace coil.

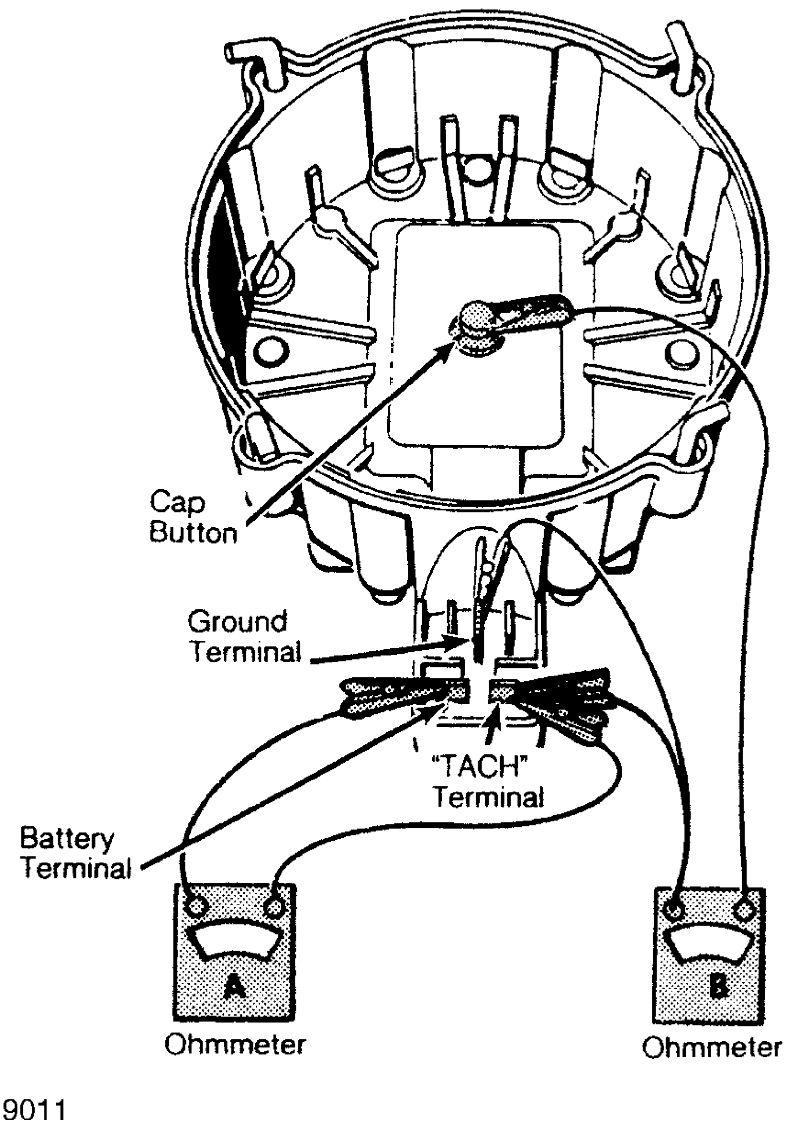


Fig. 5: Coil Test Connections
Courtesy of General Motors Corp.

PICK-UP COIL

NOTE: Activation of the vacuum advance may align trigger wheel tooth and pick-up coil pole piece causing ohmmeter pointer to deflect. This deflection should not be diagnosed as a faulty pick-up coil.

1) Isolate 2 pick-up coil lead wires. Remove pick-up coil connector from module. Connect ohmmeter to either terminal and ground. See Fig. 6. Connect pump and apply vacuum to test vacuum advance unit. Replace vacuum advance unit if inoperative. Connect ohmmeter to pick-up coil terminals. Operate vacuum pump and observe ohmmeter throughout the vacuum range.

2) Attach ohmmeter to one pick-up coil terminal and distributor housing. Set ohmmeter to middle scale. Operate vacuum advance throughout vacuum range. Reading should be infinite at all times. If not, replace pick-up coil. See Meter "A" in Fig. 6.

3) Connect ohmmeter leads to pick-up coil connector termials. Operate vacuum pump to ensure proper operation throughout vacuum range. Flex terminal wires by hand to check for possible intermittent defects in wiring or connectors. Pick-up resistance should be 500-1500 ohms. If resistance is incorrect, replace the pick-up coil. See Meter "B" in Fig. 6.

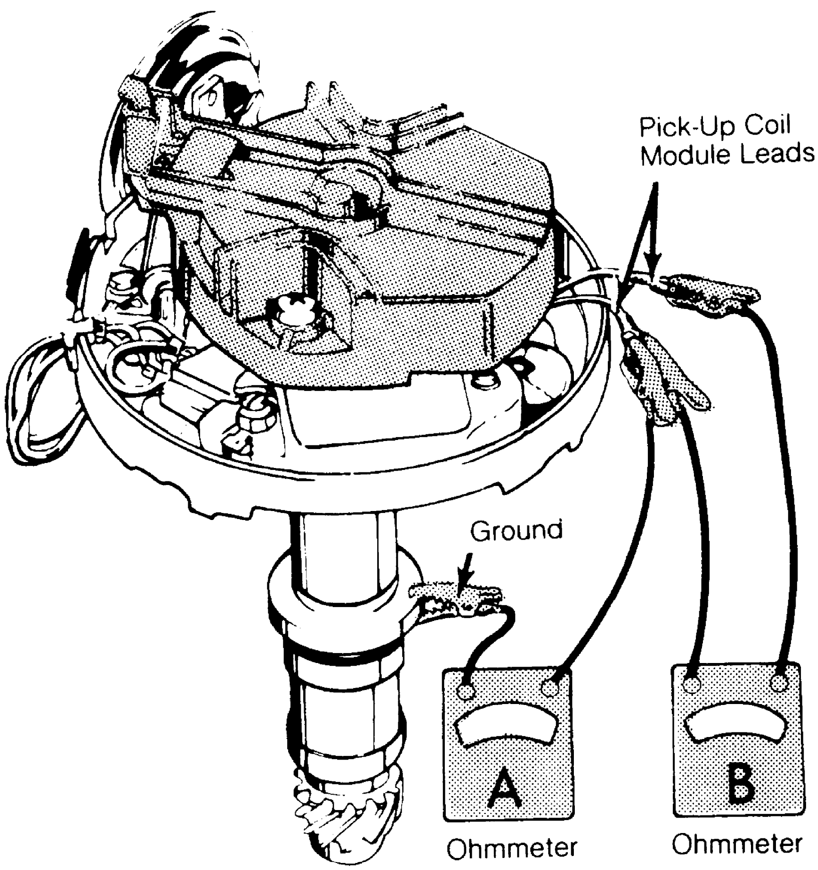


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Fig. 6: Pick-Up Coil Test Connections
Courtesy of General Motors Corp.

CAPACITOR

The capacitor is used for radio noise supression. Set ohmmeter at x1000 scale. Disconnect capacitor. Touch ohmmeter leads to capacitor terminal and ground. Slight needle movement will occur rapidly and return to infinity. A continuous reading other than infinity indicates defective capacitor.

COMPONENT TESTING (HEI WITH EST)

COIL RESISTANCE CHECK

Externally Mounted Ignition Coil (Sealed Module Connector Distributor)

Remove coil connectors and secondary coil wire. In test "A", use high ohmmeter scale. See Fig. 7. If continuity is present, replace coil. In test "B", use low ohmmeter scale. Reading should be very low or near zero. If not, replace coil. In test "C", use high ohmmeter scale. If there is no continuity, replace coil.

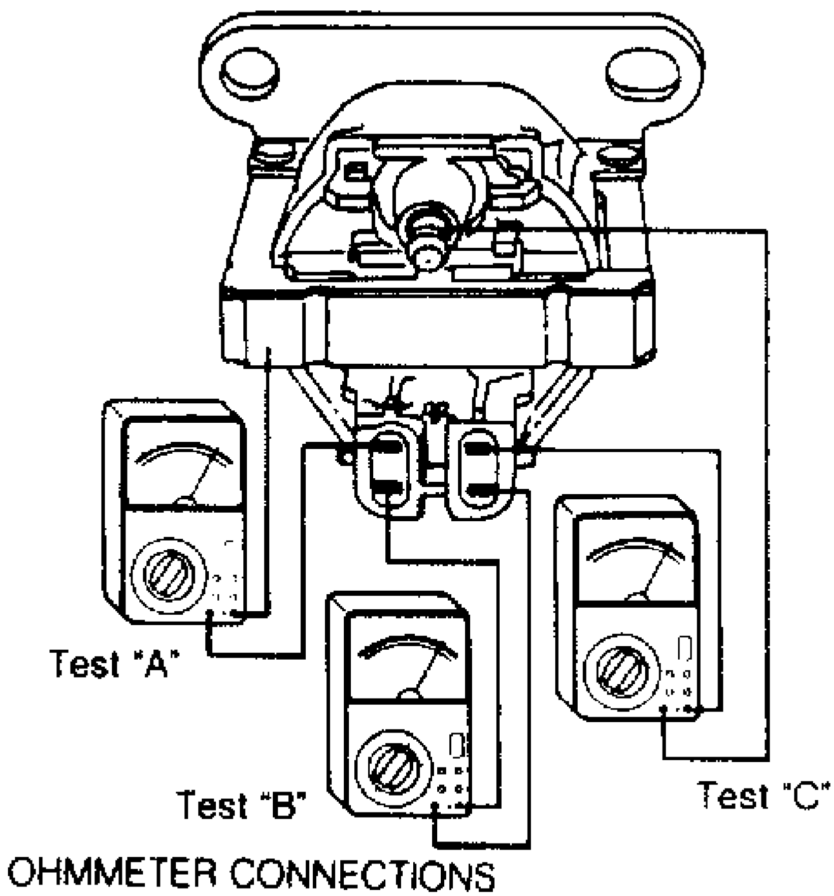

Fig. 7: Testing Ignition Coil Resistance, External coil system shown. Courtesy of General Motors Corp.

Integrally Mounted Ignition Coil

1) Turn ignition off. Remove the distributor cap and coil

assembly. Turn upside down. See Fig. 8. Set ohmmeter to low scale. Connect leads to coil "BAT" and "TACH" terminals. If resistance exceeds one ohm, replace ignition coil.

2) Set ohmmeter on high scale. Connect one lead to coil secondary terminal and the other lead first to "TACH" terminal and then to ground terminal. If resistance reading in BOTH instances is infinity, replace ignition coil.

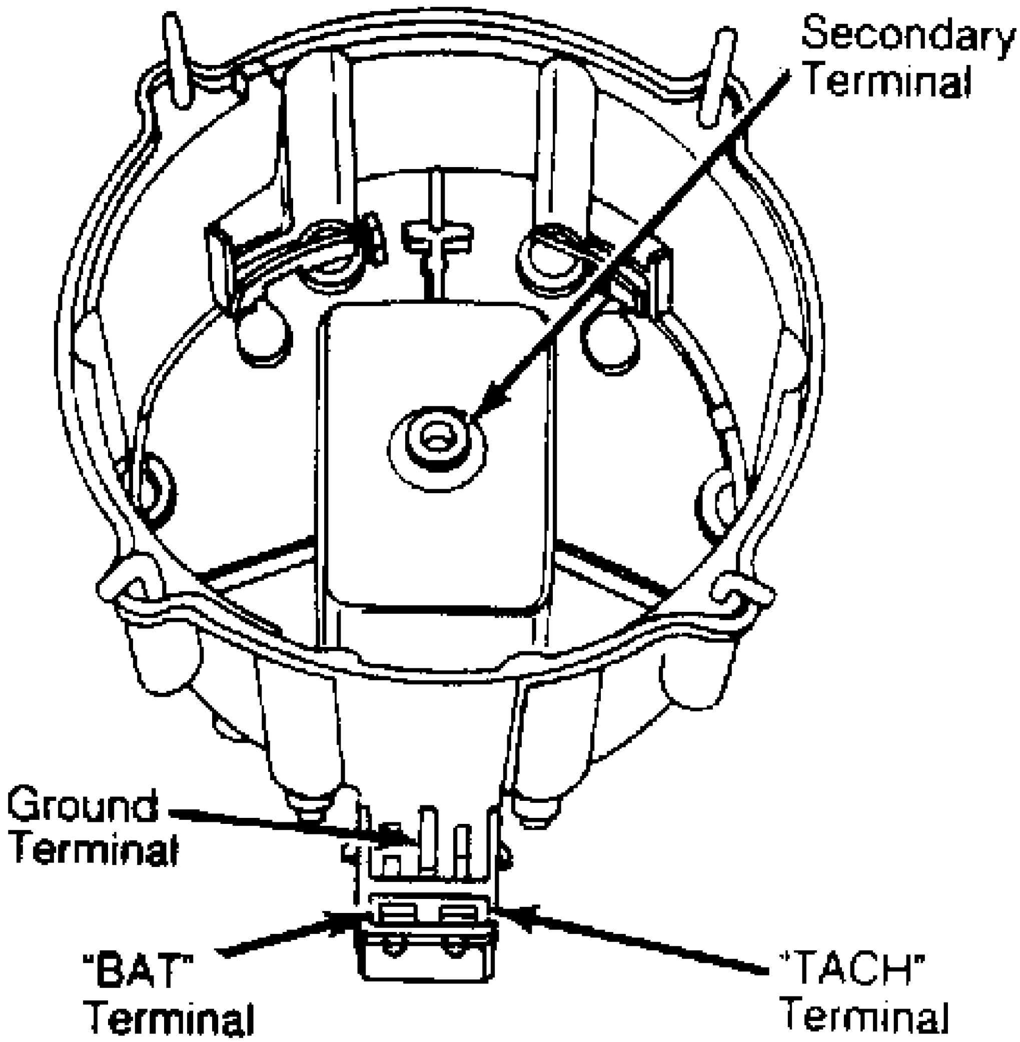

Fig. 8: Testing Ignition Coil Resistance, Integral coil system shown. Courtesy of General Motors Corp.

PICK-UP COIL SHORT & RESISTANCE CHECKS

1) Disconnect pick-up coil leads from HEI/EST module terminals "N" and "P". Set ohmmeter to middle scale and connect one lead to either pick-up coil lead and the other lead to distributor housing. See Fig. 9. Flex pick-up coil leads by hand to check for intermittent shorts to ground. Reading should be infinity at all times. If not, replace pick-up coil.

2) Connect ohmmeter between both pick-up coil leads. Check for intermittent opens by flexing wires and connectors. Resistance should be 500-1500 ohms. If not, replace pick-up coil.

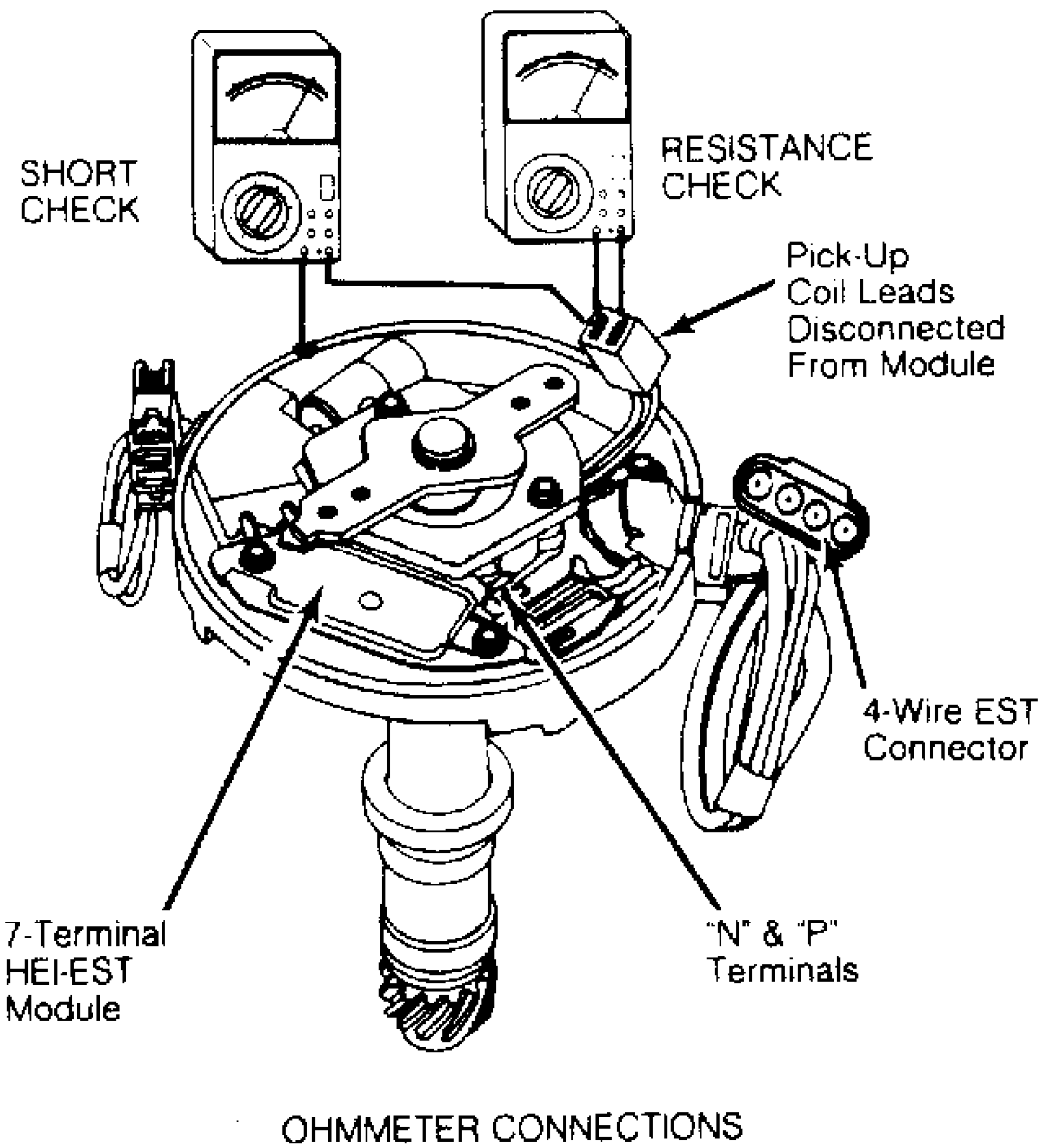

Fig. 9: Checking Distributor Pick-Up Coil, Integral coil system shown. External coil testing is similar
Courtesy of General Motors Corp.

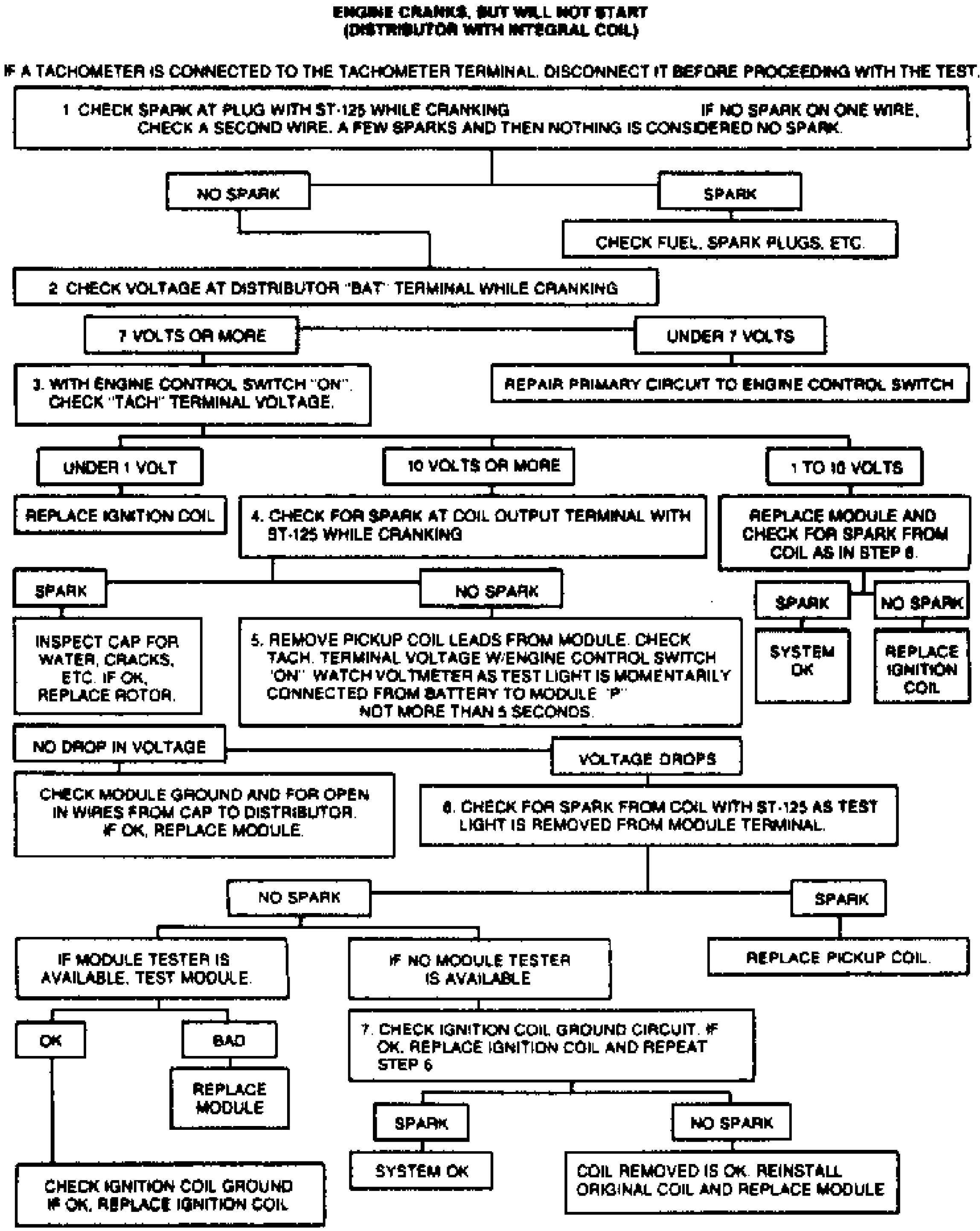

Fig. 10: Integral Coil Spark Tester (ST-125) Hook-Up
Courtesy of General Motors Corp.

NOTE: Diagnosis of HEI systems with EST and EST/ESC require thorough understanding of Computer Command Control (CCC)

system. For testing, see appropriate IGNITION SYSTEM CHECK flow chart in COMPUTERIZED ENGINE CONTROLS section. For diagnosis of HEI system, refer to following diagnostic chart. See Fig. 11.

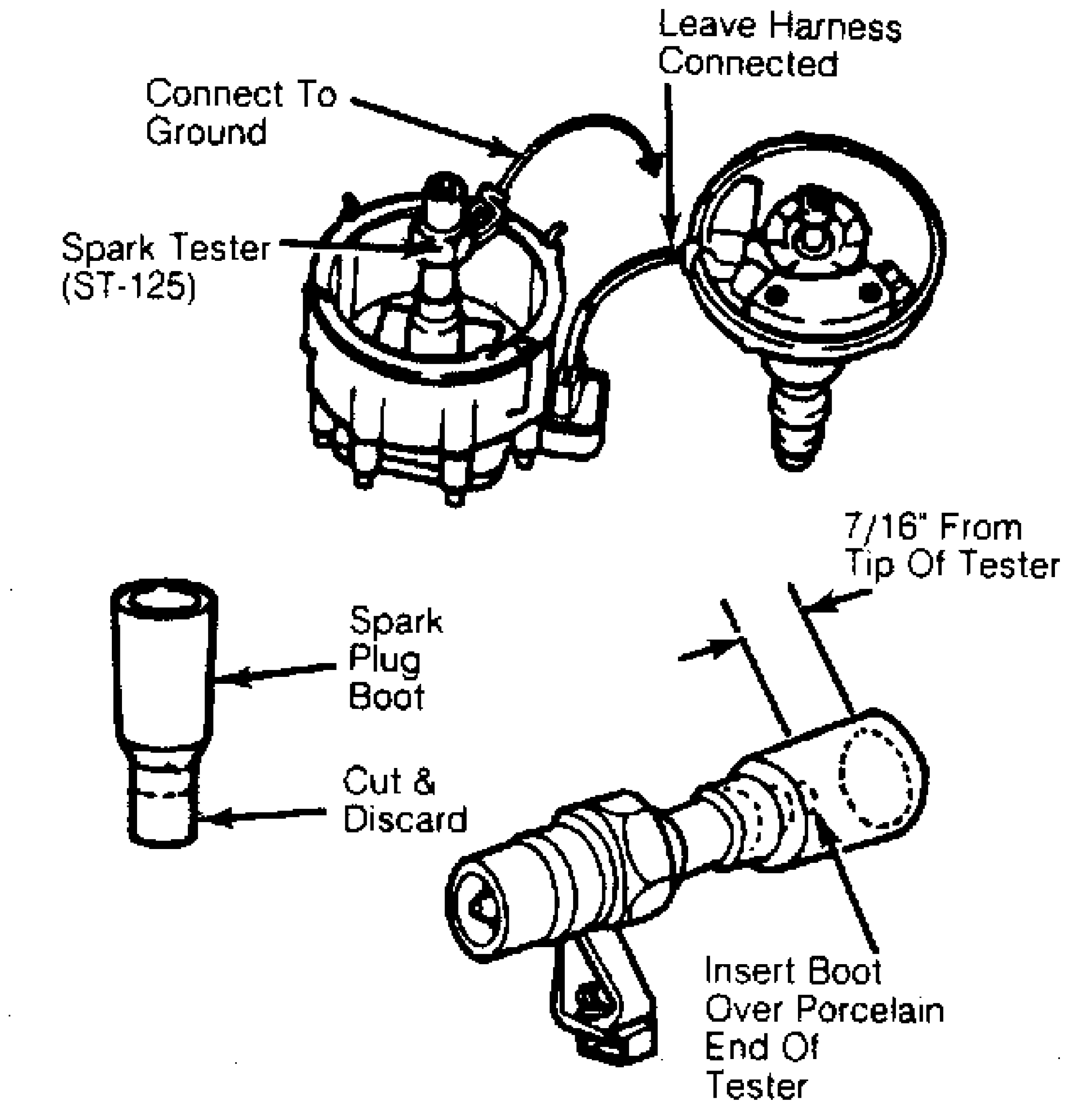

Fig. 11: Ignition Sys Check (HEI Only), Testing applies to HEI sys with mechanical weights and vacuum advance.
Courtesy of General Motors Corp.

OVERHAUL

REASSEMBLY

Ensure pick-up assembly arm is correctly installed on pin. If not, arm can float and cause ignition timing to vary. To prevent corrosion, ensure module terminals are lubricated with petroleum jelly before installation. To prevent heat damage, coat bottom of module and module rest pad in housing with silicone grease. Before installation of roll pin in driven gear, ensure timing mark on roll pin and rotor tip align. See Figs. 12 through 14.

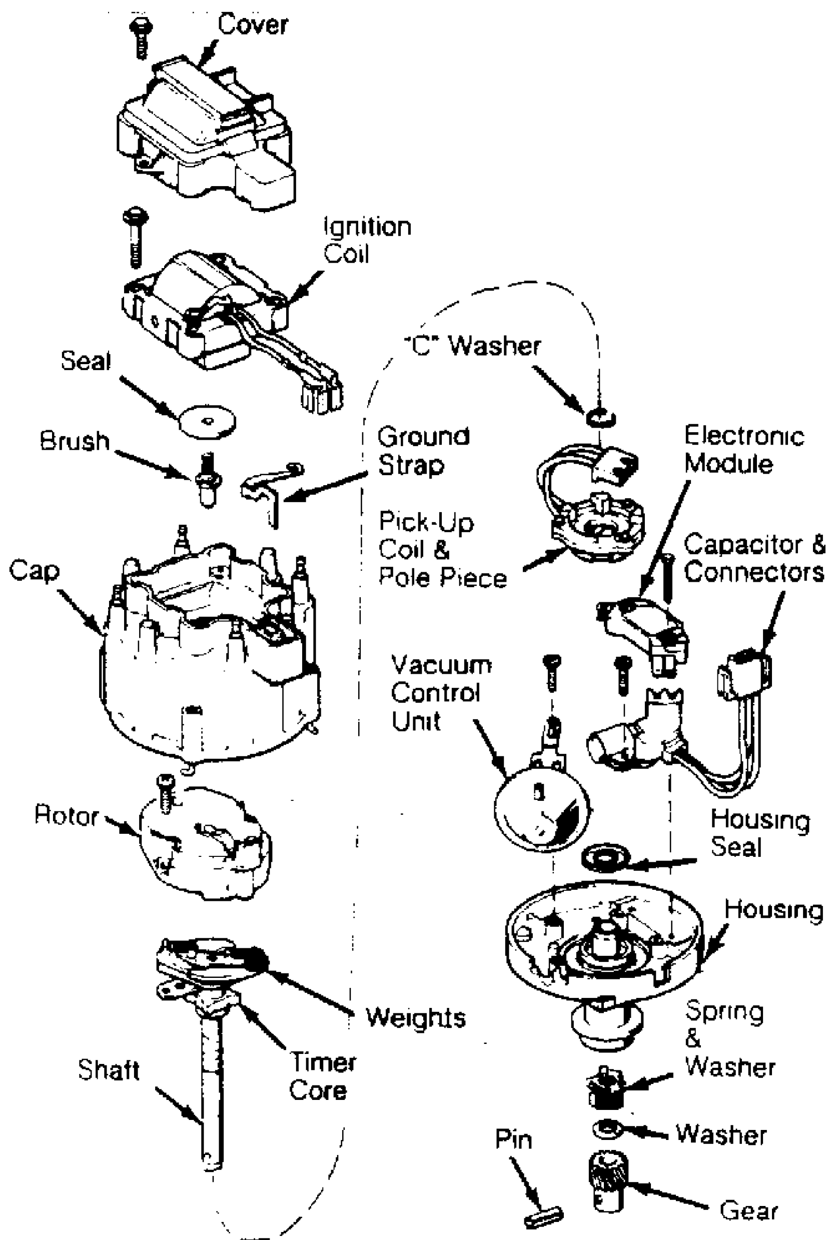

Fig. 12: Exploded View of HEI Distributor
Courtesy of General Motors Corp.

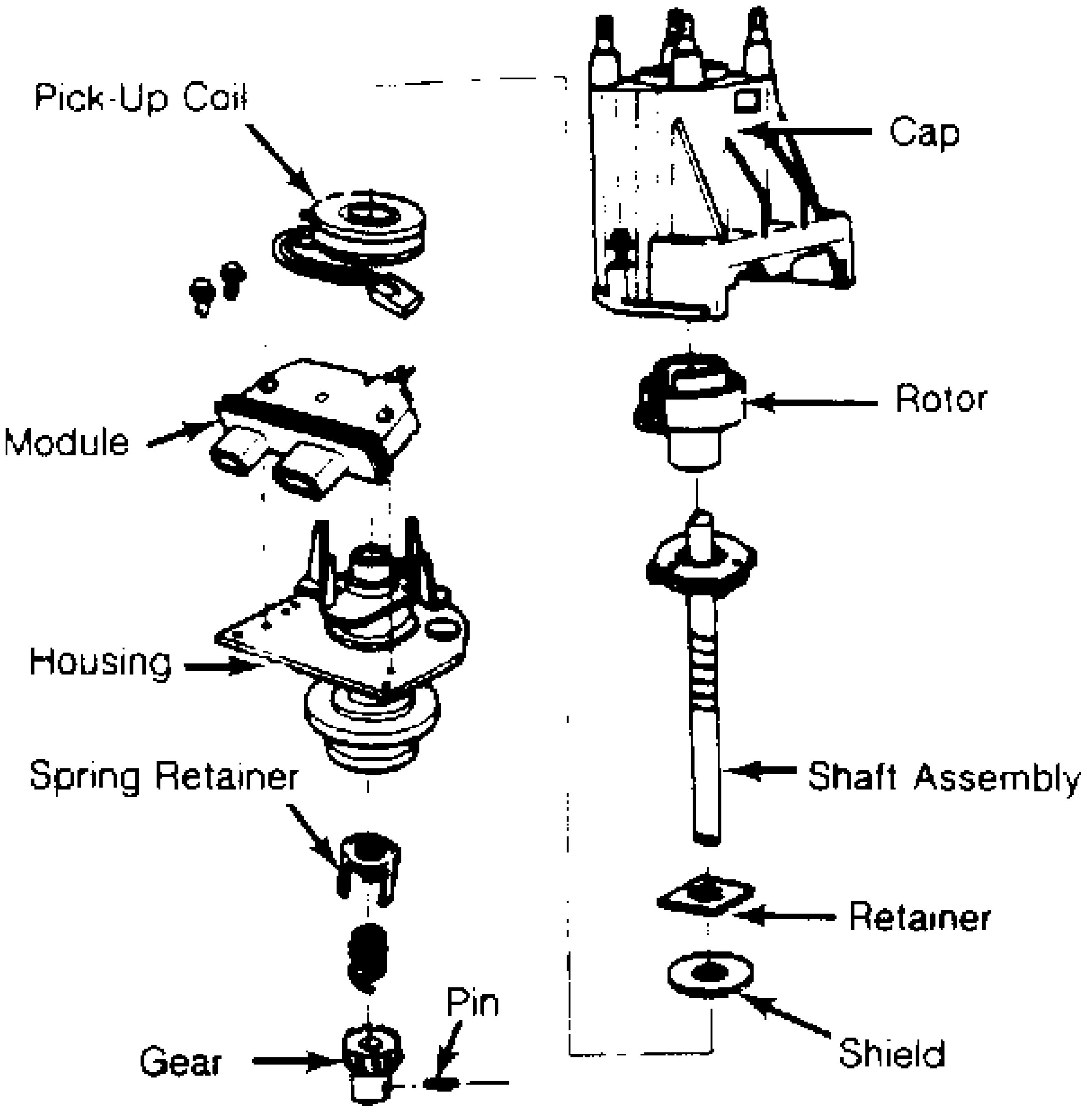

Fig. 13: Exploded View of HEI-EST Distributor With Sealed Connector
Courtesy of General Motors Corp.

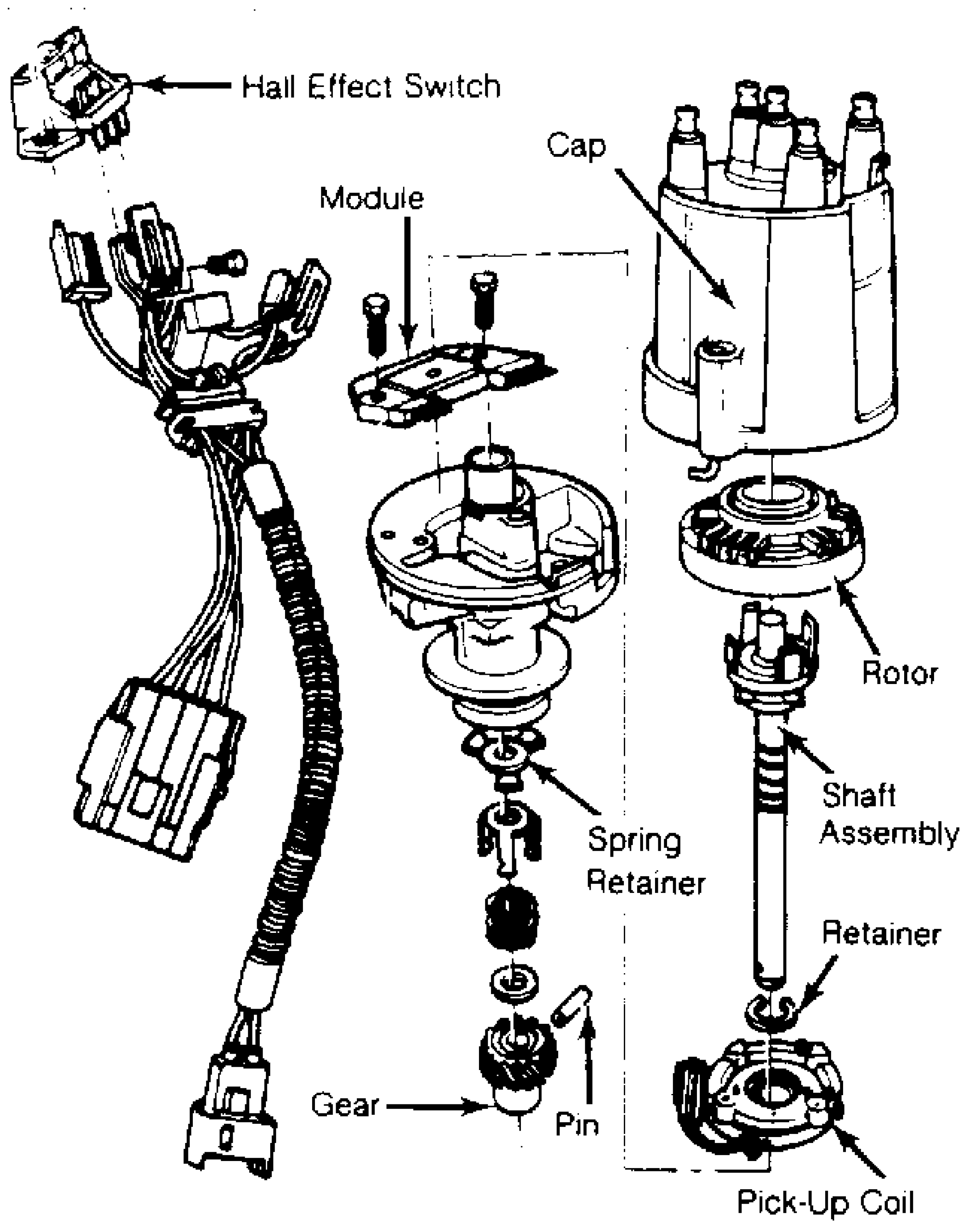

Fig. 14: Exploded View of HEI Distributor Without Sealed Connector
Courtesy of General Motors Corp.

INSTRUMENT PANEL - STANDARD

1988 Jeep Cherokee

1988 Switches & Instrument Panels
JEEP

DESCRIPTION & OPERATION

Instrument panel is composed of speedometer housing, tachometer and instrument cluster gauges.

FUEL GAUGE

System consists of a fuel gauge, an in-tank sending unit, and appropriate wiring. Fuel gauge is grounded through variable resistor of sending unit. A float attached to a slide rheostat follows fuel level and varying resistance increases or decreases indicator reading.

TEMPERATURE GAUGE

System consists of gauge and sending unit and appropriate wiring. The gauge is grounded through variable resistor of sending unit. Changes in coolant temperature vary resistance in sending unit, increasing or decreasing indication on gauge.

VOLTMETER

The voltmeter indicates regulated voltage to provide an indication of charging system's ability to maintain battery charge.

OIL PRESSURE GAUGE

The oil pressure gauge system consists of gauge and a variable resistance sending unit. Gauge needle, attached to bi-metallic strip, responds to temperature changes.

REMOVAL & INSTALLATION

INSTRUMENT CLUSTER

Removal & Installation

1) Disconnect negative battery cable. On models with cruise control, reach behind instrument cluster and disconnect speedometer cable from speed switch. See Fig. 1.

2) On models without cruise control, raise vehicle on hoist. Disconnect speedometer cable from transfer case (or transmission) and at frame rail bracket. Move speedometer cable forward and upward to provide slack. Lower vehicle.

3) On all models, remove instrument panel bezel screws and bezel. Remove screws attaching cigarette lighter and switch housings to instrument panel. Move housings aside.

4) Remove screws attaching cluster to instrument panel and carefully pull cluster and speedometer toward rear of vehicle. Disconnect wiring harness connectors.

5) Squeeze speedometer cable locking tabs and disconnect cable from speedometer. See Fig. 1. Remove instrument cluster. To install, reverse removal procedure.

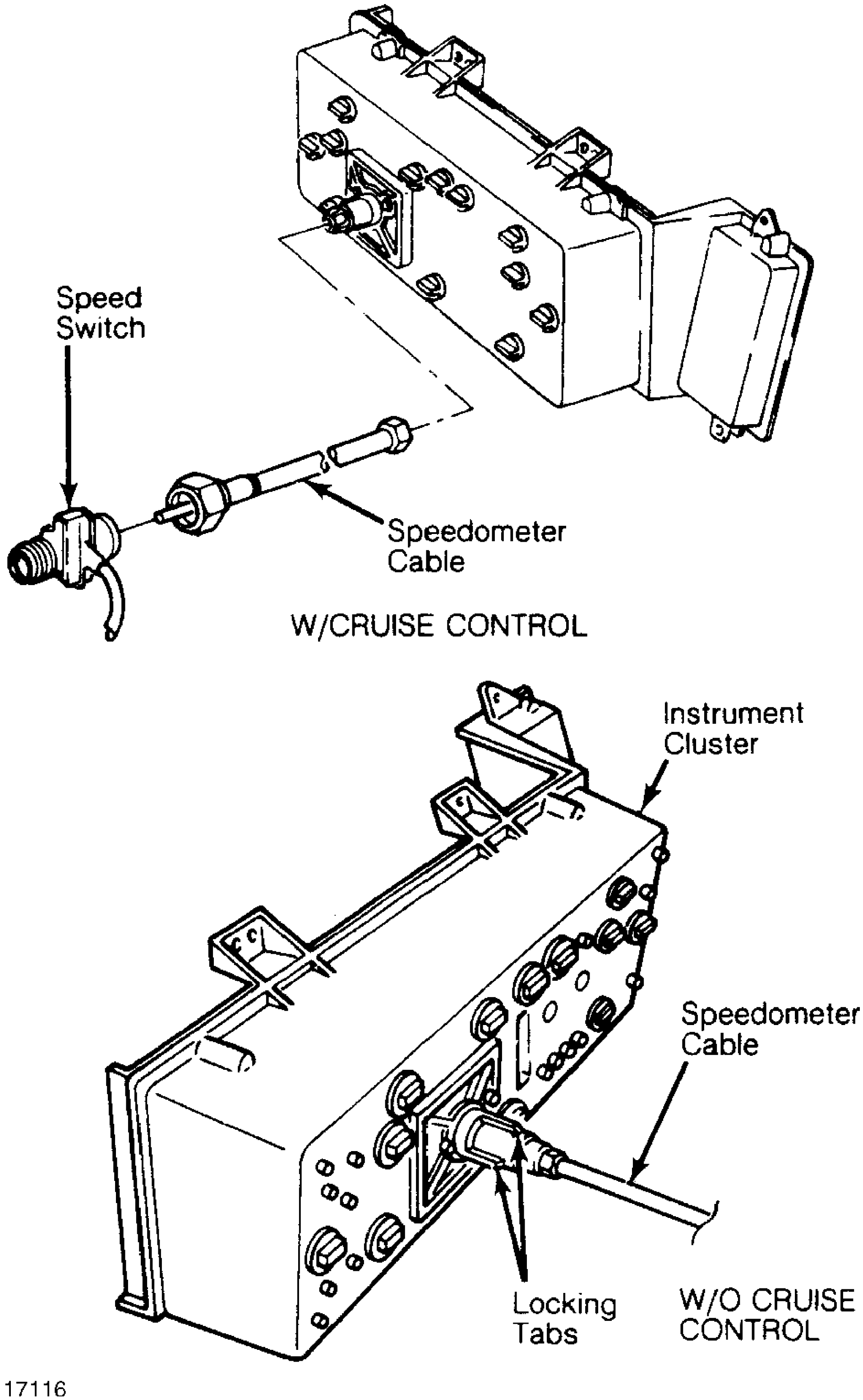

Fig. 1: Speedometer Cable Disconnect Points
Courtesy of Chrysler Motors.

SPEEDOMETER & TACHOMETER

Removal & Installation

Remove and disassemble instrument cluster. Remove speedometer, tachometer, or gauge being serviced. To install, reverse removal procedure.

JACKING & HOISTING

1988 Jeep Cherokee

1988 Jacking & Hoisting
JEEP

HOISTING

FRAME CONTACT HOIST

Cherokee, Comanche, Wagoneer & Wrangler

Vehicle may be raised on single or twin-post swiveling arm or ramp-type drive hoists. If using swiveling arm hoist, ensure lifting pads are positioned evenly on frame rails at points "A" and "B". Ensure lifting pads are not contacting transfer case or skid plate. All hoists should be equipped with proper adapters to support vehicle at frame rails only.

Grand Wagoneer

Vehicle may be raised on single or twin-post swiveling arm or ramp-type drive hoists. If using swiveling arm hoist, ensure lifting pads are positioned evenly on frame rails and lifting pads are not contacting transfer case or skid plate. All hoists should be equipped with proper adapters to support vehicle at frame rails only.

JACKING

FLOOR JACK

Cherokee, Comanche, Wagoneer & Wrangler

Vehicle may be raised by positioning jack at points "A" and "B" only. Never attempt to raise the vehicle with the jack positioned under the axle tubes, body side sills or front suspension arms. Use the sub frame rail lift points only.

Grand Wagoneer

Vehicle may be raised by positioning jack under the front or rear frame rails. Never place jack under front or rear axle tubes, or under shock absorber mounting brackets.

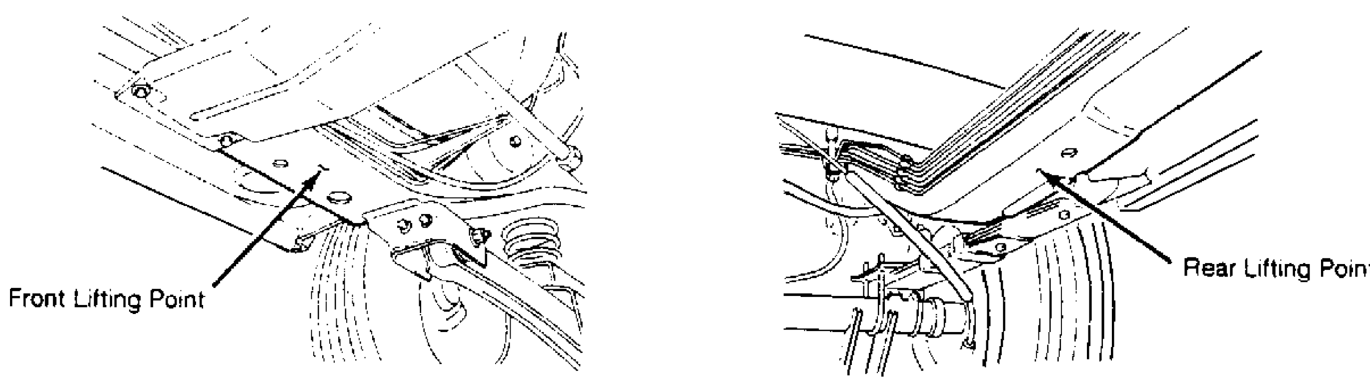

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Fig. 1: Hoisting & Jacking Points
Position lifting pads evenly on frame rails.

LOCKING HUBS - AUTOMATIC

1988 Jeep Cherokee

1988 Locking Hubs - Command-Trac & Selec-Trac

Jeep

DESCRIPTION & OPERATION

Command-Trac locking hub is used on Model 30 front axles. This system can be shifted between 2WD and 4WD high range while vehicle is moving. The only time vehicle must be stopped to shift into or out of 4WD is when shifter is in low range. See Fig. 1.

Selec-Trac locking hubs allow full or part time 4WD. Used on Model 30 front axles, system can be shifted into 2WD or 4WD modes only when vehicle is stopped. See Fig. 2.

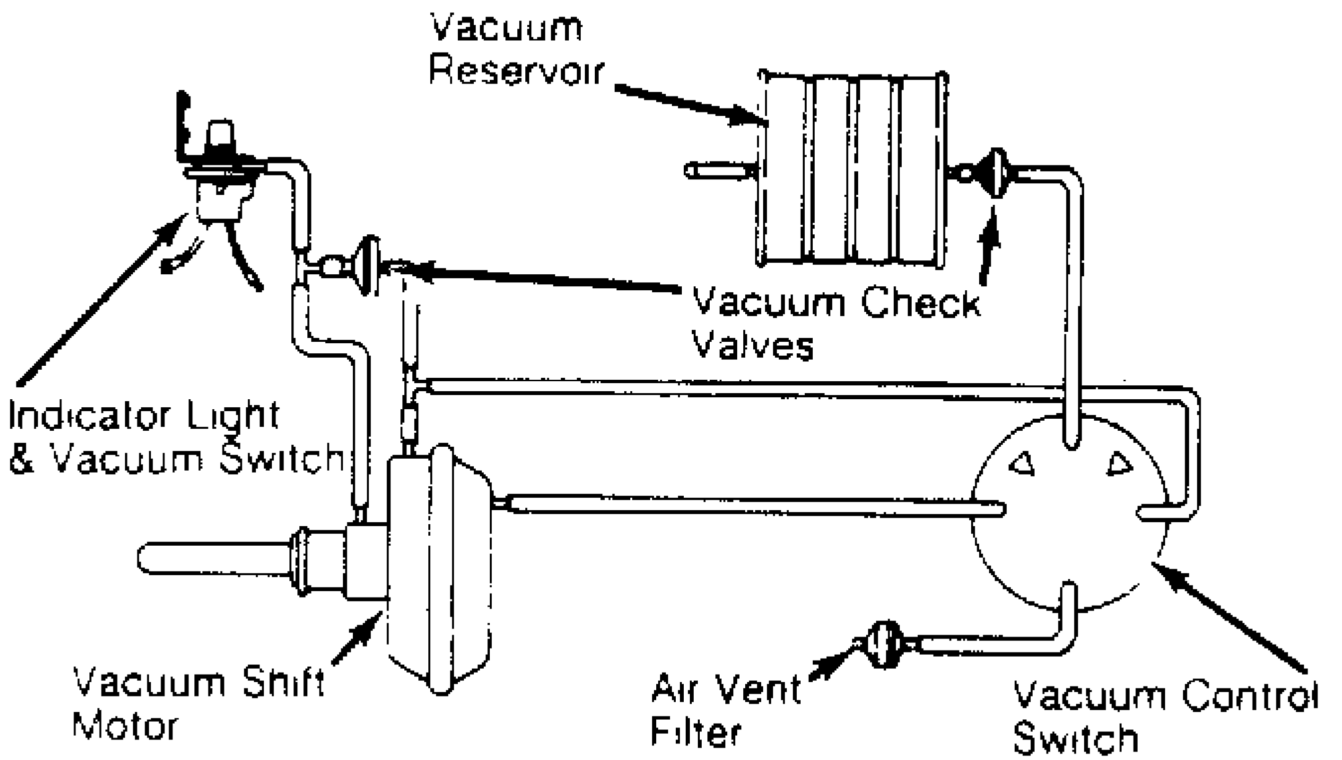


Fig. 1: Command-Trac Vacuum Control System

TROUBLE SHOOTING

SELEC-TRAC SYSTEM

2WD To 4WD

Position mode select switch to "4WD" position while driving vehicle 2-3 MPH. Axle should ratchet and clunk into position. Transfer case should shift after axle shifts, accompanied by hissing sound from mode selector switch.

4WD To 2WD

1) Position mode select switch to "2WD" position. Transfer case should shift to 2WD and not allow shifting into 4WD or "LO" range. Axle should shift after transfer case shifts.

2) To determine if front axle has completed a shift out of 4WD into 2WD, position mode select switch back to "4WD" position while operating vehicle at slow speed. If vehicle shifts into 2WD, axle will ratchet. If shift is not completed, transfer case will shift into 4WD and hissing sound will come from mode select switch.

FRONT AXLE SHIFT MOTOR TEST

1) Disconnect vacuum harness from front axle shift motor. Connect vacuum pump to shift motor front port. Apply 15 in. Hg vacuum to shift motor. Rotate right front wheel to disengage axle.

2) Shift motor should hold vacuum at least 30 seconds. If not, replace motor. If motor does hold vacuum, disconnect vacuum pump from shift motor front port. Connect pump to shift motor rear port and cap transfer case connecting port. Apply 15 in. Hg vacuum to motor.

3) Shift motor should hold vacuum for at least 30 seconds. If not, replace motor. If motor does hold vacuum, remove cap from shift motor transfer case connecting port and check for vacuum. If no vacuum is present, rotate right front wheel to ensure axle has shifted completely. Axle must completely shift to open shift motor connecting port.

4) Recheck vacuum at shift motor transfer case port. If vacuum is present, transfer case requires diagnosis. Command-Trac uses Model 207 transfer case. Selec-Trac uses Model 228 transfer case.

REMOVAL & INSTALLATION

LOCKING HUB

Removal

1) Remove cover to outer clutch housing. Remove bearing race spring assembly. Remove sealing ring and seal bridge retainer. Remove bearing components.

2) Squeeze tangs of wire retaining ring together with needle-nose pliers. Pull remaining components of automatic hub from wheel.

Installation

1) Ensure lock ring is in position. Using Bearing Nut Wrench (J-6893-D), tighten wheel bearing adjusting nut to 50 ft. lbs. (60 N.m) to seat bearings.

2) Back off nut and tighten to 35 ft. lbs. (47 N.m) while rotating hub. Finally, back off nut a maximum of 3/8 turn. Assemble lock ring (with tab in keyway) over axle shaft, against bearing adjustment nut.

3) Adjustment nut pin must pass through one of the washer holes. Tighten outer adjusting nut to 183 ft. lbs. (248 N.m). Align outer clutch housing splines with splines of wheel hub.

4) Loosen cover screws 3 or 4 turns, and push in on cover to allow retaining ring to expand into rotor hub groove. Tighten cover cap screws to 40-50 INCH lbs. (4.5-5.6 N.m).

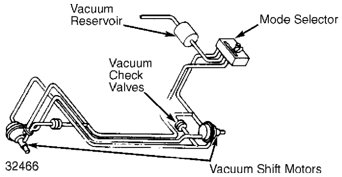


Fig. 2: Selec-Trac Vacuum Control System

AXLE SHIFT MOTOR & HOUSING

Removal

1) Raise and support vehicle. Drain shift housing fluid. Disconnect vacuum harness. Remove housing bolts. Remove motor and housing. Mark shift fork and housing for reassembly. See Fig. 3.

2) Rotate shift motor. Remove shift fork and motor snap rings. Remove shift motor from housing. Remove "O" ring from motor. Always use a new "O" ring for reassembly.

Installation

Install new "O" ring on motor shaft. Install motor into housing and slide shift fork onto shaft. Position motor and housing on axle. Add axle lubricant to shift motor housing. Install shift fork in shift collar and install housing bolts. Connect all vacuum harnesses to motor.

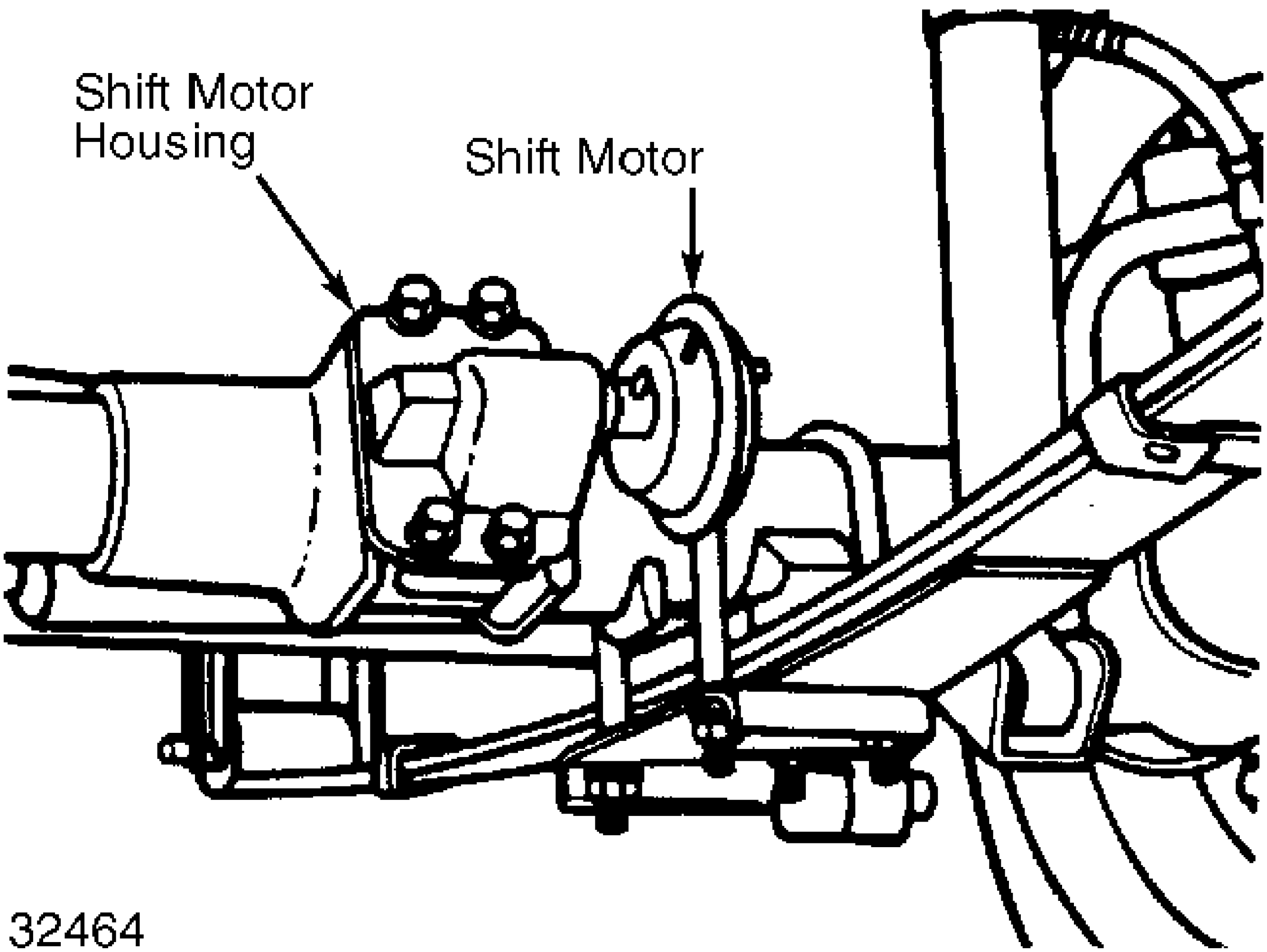


Fig. 3: Shift Motor & Housing

MAINTENANCE INFORMATION

1988 Jeep Cherokee

1984-88 MAINTENANCE
AMC/Jeep Maintenance Information

Jeep; Cherokee,
Wagoneer

* PLEASE READ THIS FIRST *

NOTE: For scheduled maintenance intervals and the related fluid capacities, fluid specifications and labor times for major service intervals, see SCHEDULED SERVICES article below:

* SCHEDULED SERVICES - GASOLINE
* SCHEDULED SERVICES - DIESEL ENGINES - NORMAL (1985-87)

Warranty information and specifications for fluid capacities, lubrication specifications, wheel and tire size, and battery type are covered in this article.

MODEL IDENTIFICATION

VIN LOCATION

The Vehicle Identification Number (VIN) is located on the left side of the dash panel at the base of the windshield. The VIN chart explains the code characters.

VIN CODE ID EXPLANATION

Numbers preceding the explanations in the legend below refer to the sequence of characters as listed on VIN identification label. See VIN example below.

(VIN)	1	J	C	U	N	7	7	1	X	G	T	0	0	0	0	0	1
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17

1 - Manufacturing Country
  1 * United States

2 - Company/Make
  J * American Motors/Jeep

3 - Type
  C * Multi-Purpose Vehicle
  D * Incomplete Vehicle
  E * Export, LHD
  F * Export, RHD

4 - Engine Type
  B * 2.1L (128 CID) 4-Cylinder Turbo (Diesel) (001B) (1985-87)
  H * 2.5L (150 CID) 4-Cylinder TBI (Gasoline) (001H) (1986-88)
  U * 2.5L (150 CID) 4-Cylinder 1-Bbl. (Gasoline) (001U) (1984-85)
  Y * 2.5L (150 CID) 4-Cylinder 1-Bbl. (Export) (001Y) (1984-85)
  W * 2.8L (171 CID) V6 2-Bbl. (Gasoline) (001W) (1984-86)
  M * 4.0L (242 CID) I-6 (Gasoline) (001M) (1987-88)

5 - Transmission/(Transfer Case)
  A * Auto Column Shift (2WD)
  B * Auto Floor Shift (Part Time 4WD)
  C * Auto Floor Shift (Full Time 4WD)
  D * Auto Floor Shift (2WD)
  E * Auto Column Shift (Part Time 4WD)
  J * Auto Column Shift (Full Time 4WD)
  L * 5-Speed Manual Floor Shift (Part Time 4WD)
  N * 5-Speed Manual Floor Shift (Full Time 4WD)
  S * 4-Speed Manual Floor Shift (2WD)
  W * 5-Speed Manual Shift (2WD)
  X * 4-Speed Manual Floor Shift (Part Time 4WD)

6-7 - Body Style
 73 * Cherokee Wagon 2-Door (2WD)
 74 * Cherokee Wagon 4-Door (2WD)
 75 * Wagoneer Wagon 4-Door (4WD)
 77 * Cherokee Wagon 2-Door (4WD)
 78 * Cherokee Wagon 4-Door (4WD)

8 - Trim Package
  1 * Custom
  2 * Pioneer
  3 * Chief
  4 * Laredo
  5 * Base
  5 * Wagoneer
  6 * Limited
  K * Cherokee Base (2WD)
  L * Pioneer (2WD)
  M * Laredo (2WD)

9 - Check Digit
  * Manufacturer Assigned

10 - Model Year
  E * 1984
  F * 1985
  G * 1986
  H * 1987
  J * 1988

11 - Assembly Plant
  T * Toledo, Ohio

12-17 - Sequential Serial Number
  * Production Sequence

MAINTENANCE SERVICE INFORMATION

SEVERE & NORMAL SERVICE DEFINITION

NOTE: Use the Severe Service schedule if the vehicle to be serviced is operated under ANY (one or more) of these conditions:

Service is recommended at specified mileage intervals of vehicle operation. Service schedules are based on the following primary operating conditions:

Severe Service

* Short Trips (About 15 Miles)

* Cold Climate Operation
* Towing Or Heavily Loading
* Severe Dust Conditions
* Sustained High Speed Operation
* Off-Road Driving
* Hot Weather, Stop-And-Go Driving
* Extensive Idling Conditions (Taxi Or Delivery Type Service)

Normal Service

* Driven More Than 10 Miles Daily
* No Severe Service Operating Conditions

CAMSHAFT TIMING BELT REPLACEMENT INFORMATION (TURBO-DIESEL)

CAUTION: Failure to replace a faulty camshaft timing belt may result in serious engine damage.

The condition of camshaft drive belts should always be checked on vehicles which have more than 50,000 miles. Although some manufacturers do not recommend belt replacement at a specified mileage, others require it at 60,000-100,000 miles. A camshaft drive belt failure may cause extensive damage to internal engine components on most engines, although some designs do not allow piston-to-valve contact. These designs are often called "Free Wheeling".

Many manufacturers changed their maintenance and warranty schedules in the mid-1980's to reflect timing belt inspection and/or replacement at 50,000-60,000 miles. Most service interval schedules reflect these changes.

Belts or components should be inspected and replaced if any of the following conditions exist:

* Cracks Or Tears In Belt Surface
* Missing, Damaged, Cracked Or Rounded Teeth
* Oil Contamination
* Damaged Or Faulty Tensioners
* Incorrect Tension Adjustment

SERVICE LABOR TIMES

SERVICE LABOR TIMES TABLE (HOURS)

Application	(1) 30,000 Mile Service	60,000 Mile Service
2.1L (Turbo Diesel)		
Automatic Transmission	4.3	4.5
Manual Transmission	3.6	3.8
2.5L		
Automatic Transmission	5.6	3.5
Manual Transmission	4.9	3.5
2.8L		
Automatic Transmission	5.8	3.7
Manual Transmission	5.1	3.7
4.0L		
Automatic Transmission	5.7	3.6
Manual Transmission	5.0	3.6

(1) - Add .8 hr. for vehicles equipped with 4WD.

SERVICE POINT LOCATIONS

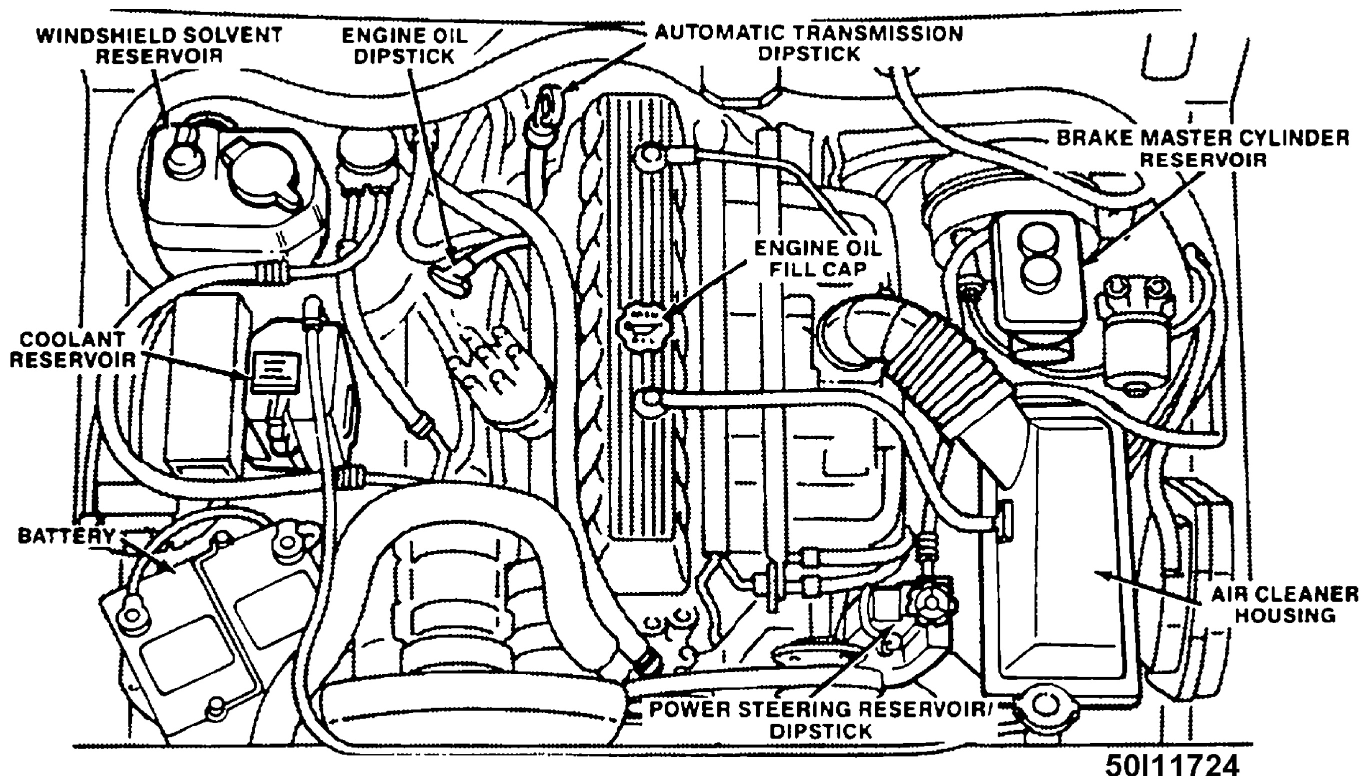


Fig. 1: Service Point Locations (Typical)
Courtesy of American Motors Corp.

NOTE: The 2.1L Turbo-Diesel engine has two (2) oil drain plugs

ADDITIONAL SERVICE INFORMATION

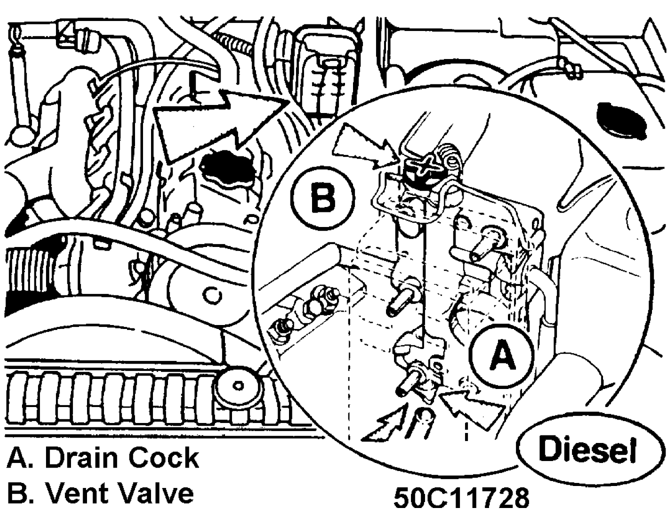


Fig. 2: Water Separator (Diesel)
Courtesy of American Motors Corp.

NOTE: For more information regarding 2.1L Turbo-Diesel engine service refer to the TUNE-UP - DIESEL article in

the ENGINE PERFORMANCE section.

Fuel filter should be drained whenever "WATER IN FUEL" warning light glows. Diesel fuel can damage asphalt and painted surfaces. Always place a drain pan under fuel filter to collect contaminated fuel. See Fig. 2.

1) Stop vehicle and turn engine off. Attach a long piece of tubing to drain cock outlet. Place end of drain hose into drain pan. Open filter assembly vent valve (Black + shaped knob) and drain cock.

2) Drain approximately 1/2 pint (.24 Liters) from fuel filter. Close vent valve and drain cock. Start engine and check for leaks. If "WATER IN FUEL" warning lamp comes on again, remove water contaminated fuel from fuel lines and fuel tank.

WARNING: DO NOT bleed fuel lines on hot engine, as high exhaust temperatures could cause fire. Use care when bleeding fuel lines, as fuel is under extreme pressure and could penetrate skin, causing personal injury. Wear safety goggles and protective clothing when bleeding fuel lines.

CAUTION: DO NOT drain fuel/water separator when engine is running or hot. Allow engine to cool before draining. Verify that the WATER IN FUEL light on instrument panel is OFF.

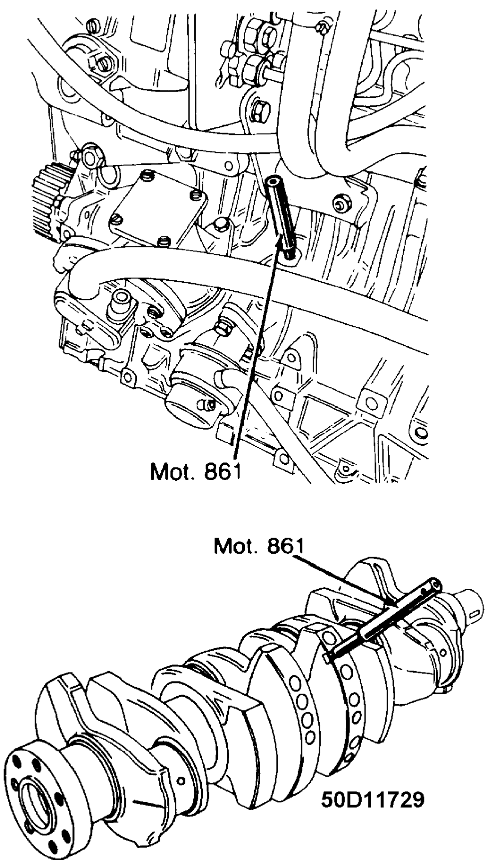


Fig. 3: Locking Crankshaft at TDC
Courtesy of American Motors/Jeep Corp.

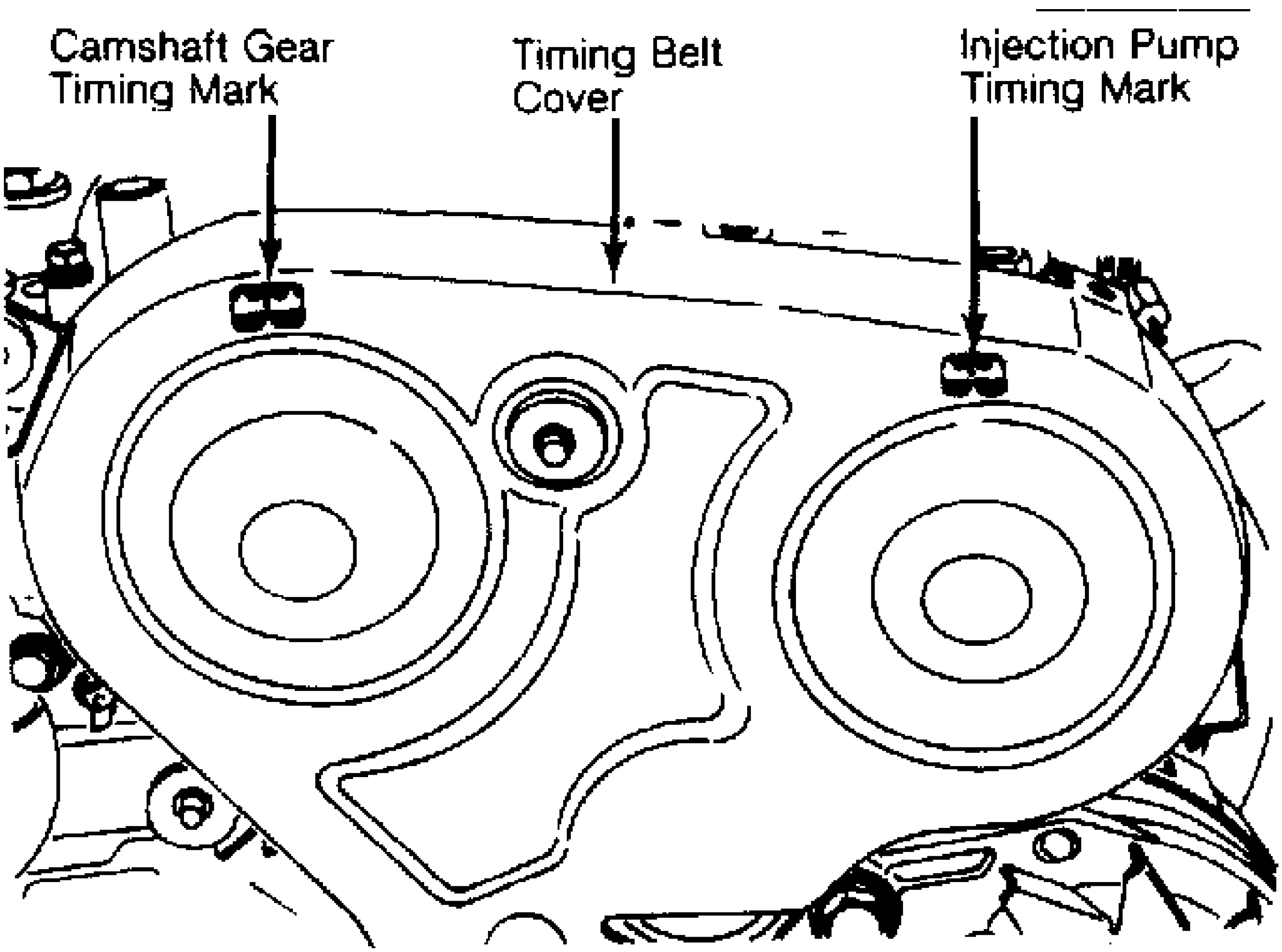


Fig. 4: Camshaft & Injection Pump Timing Marks
Courtesy of American Motors/Jeep Corp.

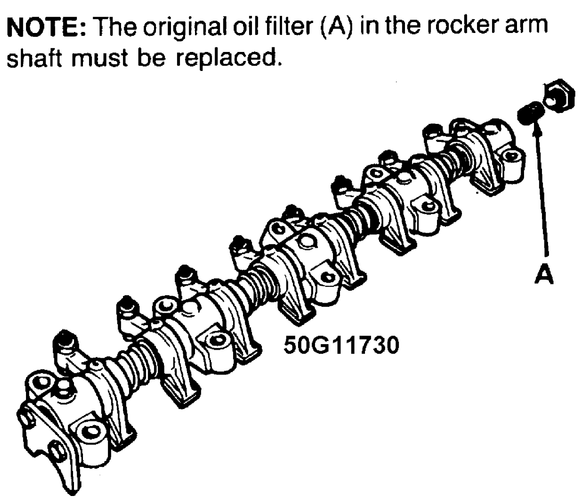
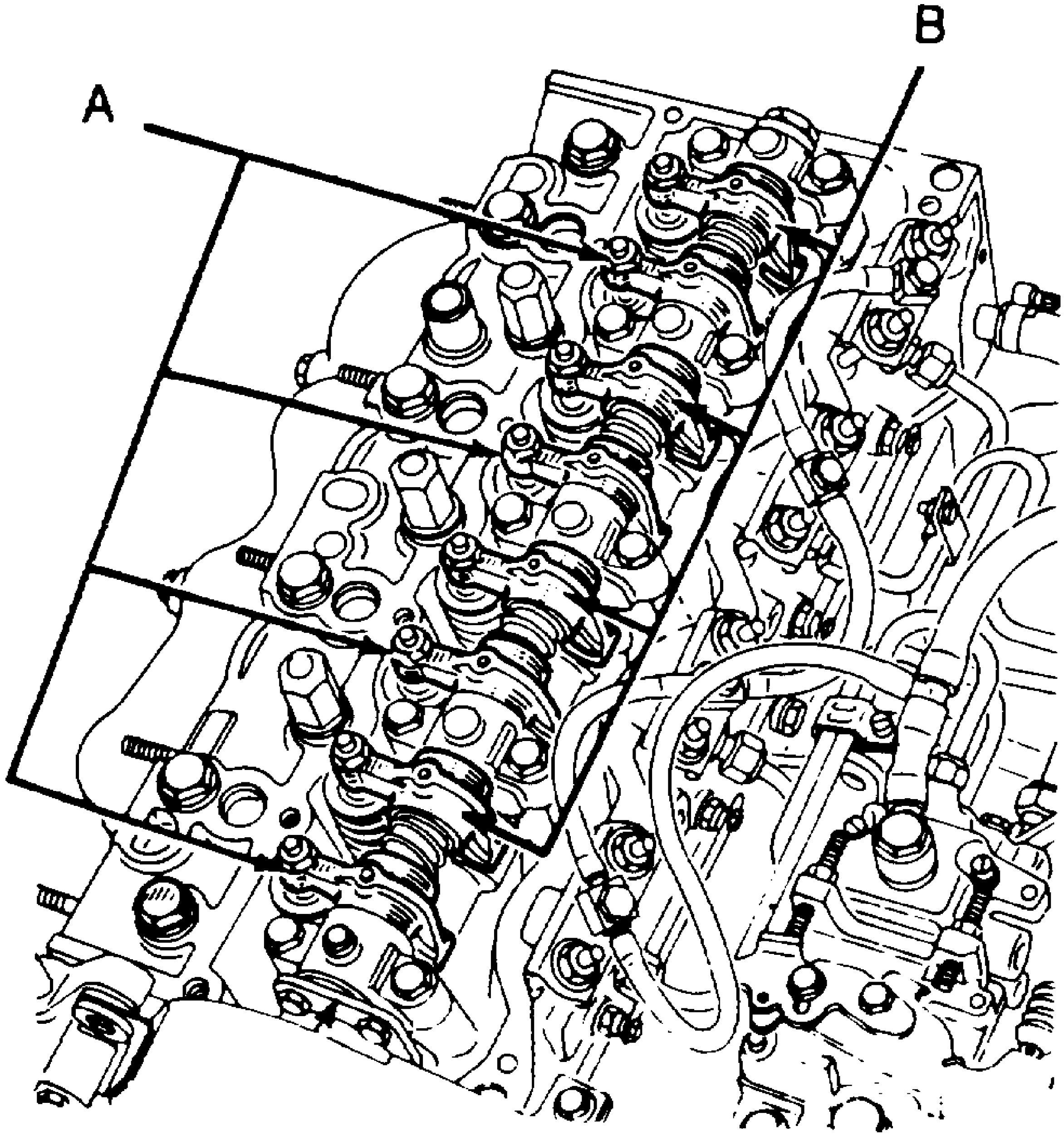


Fig. 5: Rocker Arm Shaft Assembly (Oil Filter Location)
Courtesy of American Motors/Jeep Corp.



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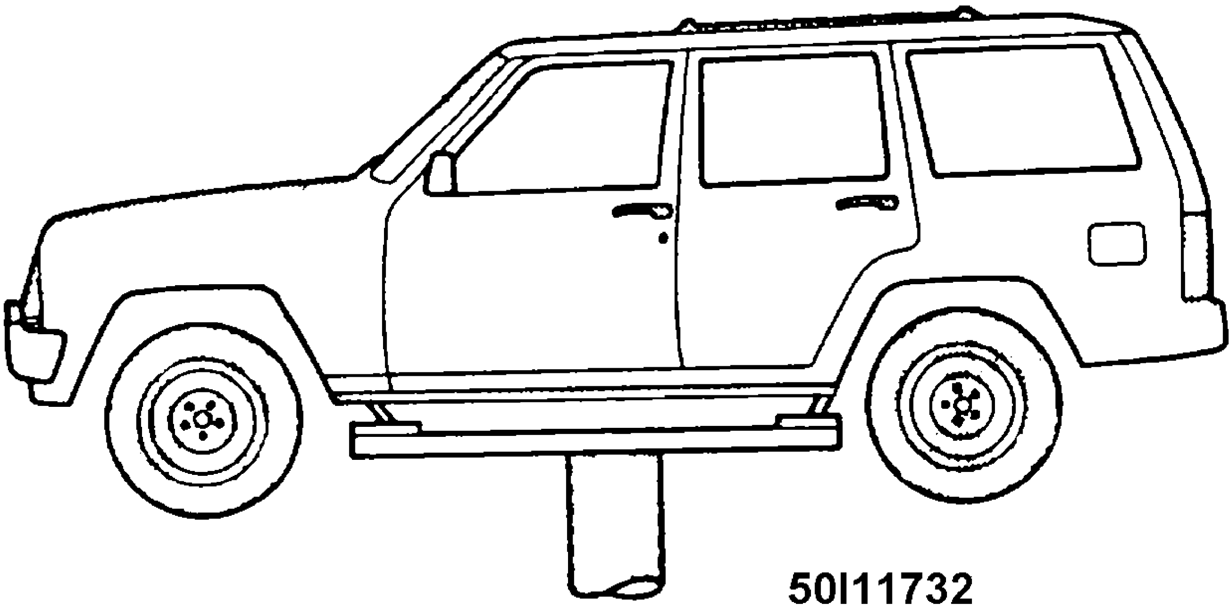
A. Intake Valve Rocker Arms
B. Exhaust Valve Rocker Arms

NOTE: The number 1 (one) cylinder is located at the flywheel/drive plate end of the engine.

Fig. 6: Valve Layout
Courtesy of American Motors/Jeep Corp.

NOTE: For more information regarding 2.1L Turbo-Diesel engine service refer to the 2.1L 4-CYL TURBO DIESEL - VIN [B]

article in the ENGINE MECHANICAL section.



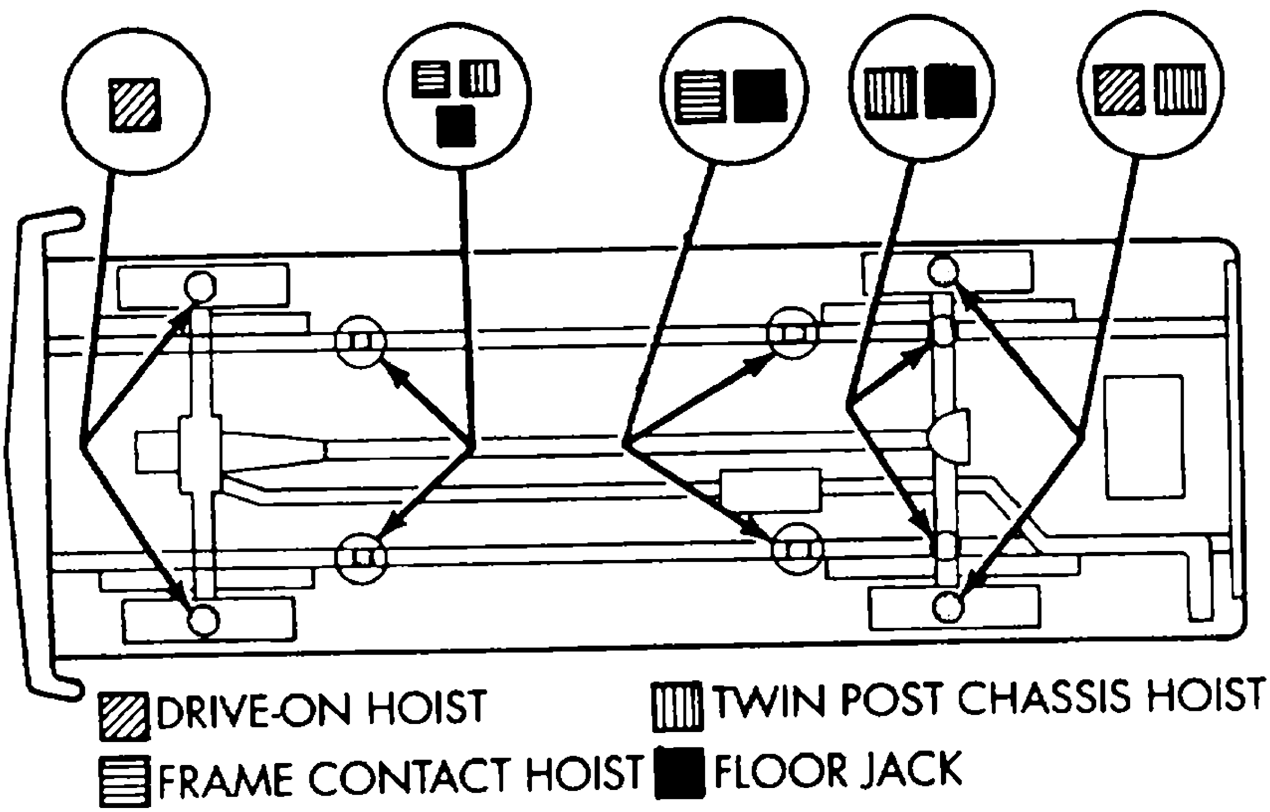


Fig. 7: Hoist Lift Point Locations
Courtesy of American Motors Corp.

NOTE: For more information regarding jacking and hoisting refer to the JACKING & HOISTING article in the

WHEEL ALIGNMENT section.

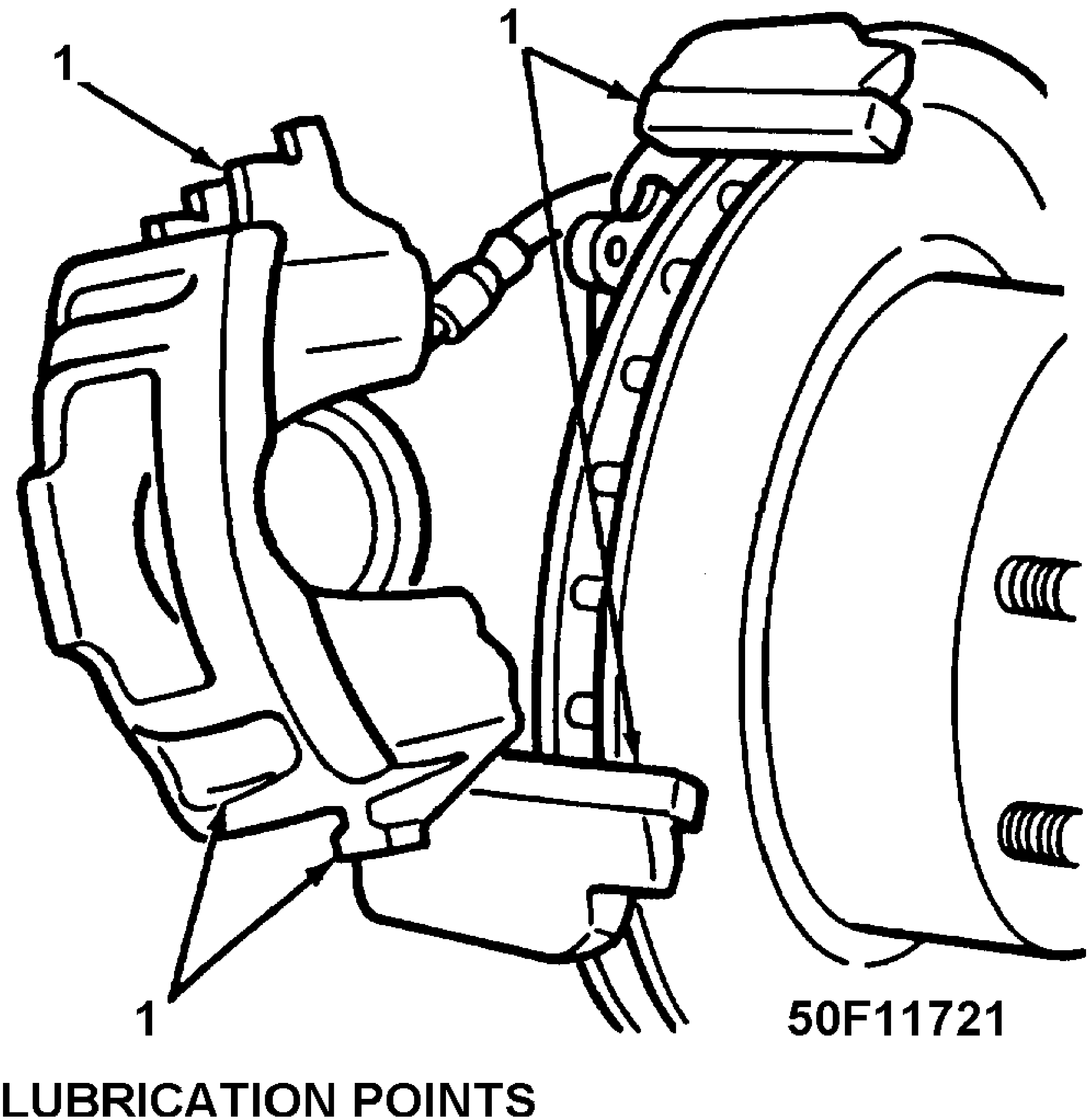


Fig. 8: Brake Caliper Lubrication Points
Courtesy of American Motors Corp.

NOTE: For more information regarding brake maintenance refer to the BRAKE SYSTEM article.

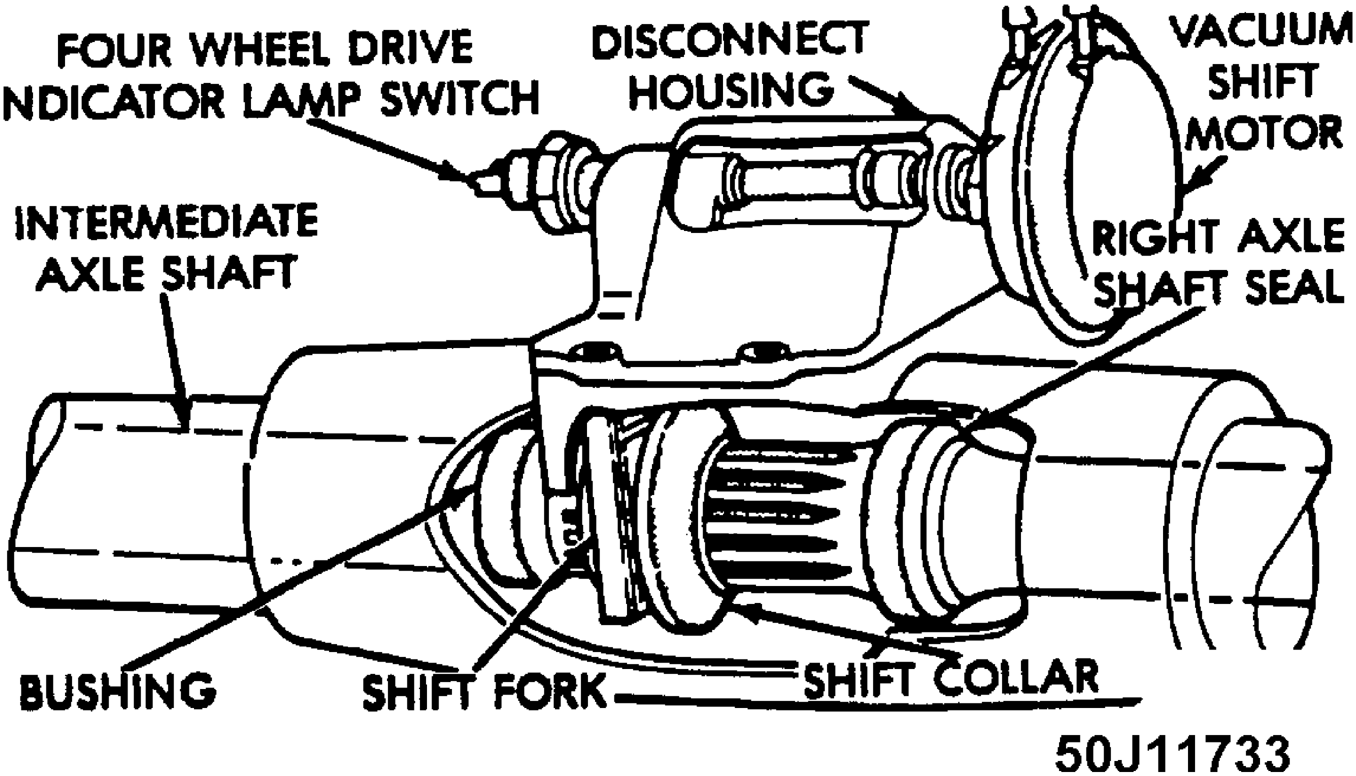
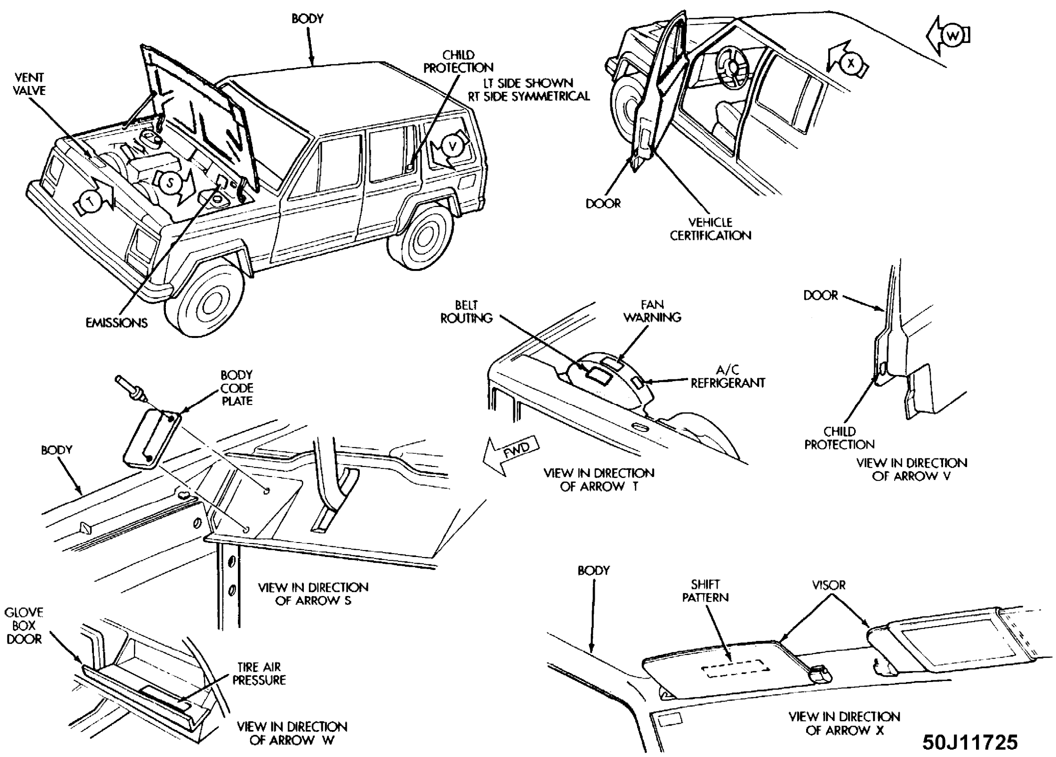


Fig. 9: Front Disconnect Housing Lubrication Point
Courtesy of American Motors Corp.

IDENTIFICATION LABEL LOCATIONS



VEHICLE, LABELS AND PLATES

Fig. 10: Identification Label Locations
Courtesy of American Motors Corp.

LUBRICATION SPECIFICATIONS

LUBRICATION SPECIFICATIONS TABLE

Application	Fluid Specifications
Automatic Transmission	Dexron-IIE ATF
Brake Master Cylinder	DOT 3 (SAE J-1703F) Brake Fluid
Engine Coolant	Alugard 340-2 & Water (50/50 Mixture)
Engine Oil (1)	
Gasoline Engine	
Temperature Range	
Above 30° F (-1°C)	SAE 20W-40 Or 20W-50 API SH/CD
Above 0° F (-18°C)	SAE 10W-30 Or 10W-40 API SH/CD
Less Than 60° F (16°C)	SAE 5W-30 API SH/CD
Diesel Engine	
Temperature Range	
Above 30° F (-1°C)	SAE 15W-40, 20W-40 Or 20W-50 API SH/CD
0° F (-18°C) to 100° F (38°C)	SAE 10W-30 API SH/CD
Less Than 50° F (10°C)	SAE 5W-30 API SH/CD
Front Axle	SAE 80W-90 API GL-5
Rear Axle	SAE 80W-90 API GL-5
Rear Axle (Trac-Lok) (2)	SAE 80W-140 API GL-5
Rear Axle (Trailer Towing) (3)	SAE 75W-140 Synthetic
Hydraulic Clutch	DOT 3 (SAE J-1703F) Brake Fluid
Manual Transmission	SAE 75W-90 API GL-5
Manual Steering Box	Multi-Purpose NLGI Grade 2EP
Power Steering Pump	Power Steering Fluid
Transfer Case	Dexron-IIE ATF

Brake Caliper Bushings	GE 661 or DOW 111 Silicone Grease
Caliper Slide Pins	GE 661 or DOW 111 Silicone Grease
Wheel Bearings	Multi-Purpose NLGI Grade 2EP, GC-LB
Drive Shaft U-Joints	Multi-Purpose NLGI Grade 2EP, GC-LB
Steering Linkage (4)(5) ...	Multi-Purpose NLGI Grade 2EP, GC-LB
Ball Joints (4)(6)	Multi-Purpose NLGI Grade 2EP, GC-LB
Engine Oil Filter (Diesel) (7)	AMC/Jeep (P/N 8983 002 656)
Weatherstrip	Silicone Spray Lubricant

(1) - SAE 10W-30 SH/CD is preferred.
(2) - Add 2 Ozs. (59 ml) of Limited-Slip differential lubricant additive when changing fluid.
(3) - For vehicles operating under heavy-duty towing conditions, use SAE 75W-140 Synthetic lube.
NOTE: Before using SAE 75W-140 Synthetic the old fluid must be DRAINED and FLUSHED with clean mineral based (non-synthetic) axle lubricant. Then refill with new synthetic lube.
(4) - Use low pressure grease gun to prevent seal damage.
(5) - Fill until lubricant squeezes out from the base of seals.
(6) - Fill ball joint until seal starts to swell.
(7) - Use of AMC/Jeep Oil Filter is RECOMMENDED.

FLUID CAPACITIES

FLUID CAPACITIES TABLE

Application	Quantity (1)
A/C System R-12 Refrigerant Capacity	36-40 Ozs.
Automatic Transmission	
1984-86 (904 HD)	
Fluid Change	4.0 Qts. (3.8L)
Overhaul (Dry Fill)	8.0 Qts. (7.6L)
1987-88	
Fluid Change	4.0 Qts. (3.8L)
Overhaul (Dry Fill)	8.5 Qts. (8.0L)
Cooling System (2)	
4-Cylinder	10.0 Qts. (9.5L)
6-Cylinder	12.0 Qts. (11.4L)
4-Cylinder Turbo Diesel (1985-87)	9.0 Qts. (8.5L)
Engine Oil	
4-Cylinder	4.0 Qts. (3.8L)
6-Cylinder	6.0 Qts. (5.7L)
4-Cylinder Turbo Diesel (1985-87)	5.5 Qts. (8.5L)
Fuel Tank	
Standard	13.5 Gals. (51.1L)
Optional	20 Gals. (75.7L)
Manual Transmission (3)	
AX4 (AISIN)	7.4 Pts. (3.5L)
T4 (Borg-Warner)	3.9 Pts. (1.8L)
AX5 (AISIN)	7.0 Pts. (3.3L)
T5 (Borg-Warner)	4.5 Pts. (2.1L)
Transfer Case	
1985-86	
Selec-Trac (229 Full-Time)	6.0 Pts. (2.8L)
Command-Trac (Part-Time 207)	4.5 Pts. (2.1L)
1987	
Selec-Trac	2.5 Pts. (1.2L)
Command-Trac	2.2 Pts. (1.0L)
1988	
Selec-Trac	3.0 Pts. (1.4L)

Command-Trac	2.2 Pts. (1.0L)
Drive Axles (3)	
Front	2.5 Pts. (1.2L)
Front (Disconnect Housing) (4)	5.0 Ozs. (0.15L)
Rear	2.5 Pts. (1.2L)
Rear (Trac-Lok) (5)	2.5 Pts. (1.2L)

(1) - Capacities are recommended or calculated levels. Always use dipstick (if available) to measure level.
(2) - Includes 2.3 Qts. for coolant recovery bottle.
(3) - Fill to bottom of filler plug hole.
(4) - Add 5 Ozs. of gear lubricant through indicator switch hole.
(5) - Add 2 Ozs. of Limited-Slip differential lubricant additive first, then add new fluid.

WHEEL & TIRE SPECIFICATIONS

WHEEL & TIRE SPECIFICATIONS TABLE

Wheel Size	Tire Size
Cherokee	
15x6 & 15x7 (Aluminum Or Steel)	P195/75R15
15x6 & 15x7 (Aluminum Or Steel)	P205/75R15
15x6 & 15x7 (Aluminum Or Steel)	P215/75R15
15x6 & 15x7 (Aluminum Or Steel)	P225/75R15
Wagoneer	
15x6 (Aluminum/Steel)	P205/75R15
All Models	
16-Inch Wheels	Compact Spare Tire

TIRE REPLACEMENT

CAUTION: Always ensure all 4 tires on the vehicle are the same size, except when using the temporary spare. The use of mismatched tires may cause unpredictable handling. Replacing original tires with tires of a different size may result in false speedometer and odometer indications.

TIRE INFLATION

The tire specification decal is located in the glove box.

WHEEL TIGHTENING

Tighten the lug nuts firmly in a crisscross pattern as shown in Fig. 11. Tighten to 95 ft. lbs (129 N.m). Always position wheel locking nut opposite valve stem in position indicated. See Fig. 11.

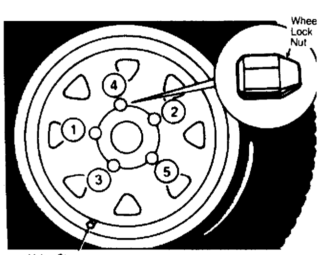


Fig. 11: Wheel Locking Nut Location
Courtesy of American Motors Corp.

BATTERY SPECIFICATIONS

CAUTION: When battery is disconnected, vehicles equipped with computers may lose memory data. When battery power is restored, driveability problems may exist on some vehicles. These vehicles may require a relearn procedure. See COMPUTER RELEARN PROCEDURES article in the GENERAL INFORMATION section.

All gasoline engine equipped models use group 58 batteries with 390 or 475 amp cold crank rating. Models with 2.1L Turbo Diesel engine use group 24 batteries with a 815 amp cold crank rating.

CAUTIONS & WARNINGS

REPLACING BLOWN FUSES

Before replacing a blown fuse, remove ignition key, turn off all lights and accessories to avoid damaging the electrical system. Be sure to use fuse with the correct indicated amperage rating. The use of an incorrect amperage rating fuse may result in a dangerous electrical system overload.

BATTERY WARNING

WARNING: When battery is disconnected, vehicles equipped with computers may lose memory data. When battery power is restored, driveability problems may exist on some vehicles. These vehicles may require a relearn procedure. See COMPUTER RELEARN PROCEDURES article in GENERAL INFORMATION section.

BRAKE PAD WEAR INDICATOR

Indicator will cause a squealing or scraping noise, warning that brake pads need replacement.

DIESEL FUEL ANTI-FUNGAL ADDITIVES

CAUTION: If fuel contamination due to fungi or other microorganisms is suspected a fuel additive with a biocide may be used. Follow the manufacturers dosage as recommended on product label. Use biocides ONLY when necessary, excessive use can may cause other fuel system problems.

DIESEL FUEL CONTAMINATION

WARNING: Diesel fuel system may be contaminated with fungi or other microorganisms. Keep contaminated fuel away from open skin cuts or sores to prevent skin irritation or infection.

DIESEL FUEL REQUIREMENTS

CAUTION: All diesel engines are to use Diesel Fuel #2 when the outside temperature is above 20°F (-7°C). In temperatures that are below 20°F (-7°C) use Diesel Fuel #1, this will reduce the chance of the fuel thickening and forming wax.

Note: A Diesel Fuel #1 & #2 combination (Blended Fuel) may be used, and is recommended for mild winter driving.

ELECTROSTATIC DISCHARGE SENSITIVE (ESD) PARTS

WARNING: Many solid state electrical components can be damaged by static electricity (ESD). Some will display a warning label, but many will not. Discharge personal static electricity by touching a metal ground point on the vehicle prior to servicing any ESD sensitive component.

ENGINE OIL

CAUTION: Never use non-detergent or straight mineral oil.

CAUTION: Do not use reclaimed fluid, mineral oil, fluid that was stored in old or open containers, or fluid inferior to AMC Standard AM 4101. Be sure to handle the fluid in clean containers that will not introduce even a slight amount of foreign liquids or particles. Such contamination of fluid could lead to hydraulic system failure.

ENGINE OIL FILTER (GASOLINE)

CAUTION: Verify that proper Oil Filter is being used. Filters with metric threads (M20 x 1.5) must be used with some engines. Other engines use SAE type (3/4" x 16) threads, and must use an oil filter with these threads. Possible engine damage can occur with improper oil filter.

ENGINE OIL FILTER (TURBO DIESEL ONLY)

CAUTION: The engine oil filter has METRIC threads. Use of a filter with improper threads can result in oil leakage and possible engine damage. Look for thread size symbol M20x1.5 on filter.

FUEL SYSTEM SERVICE

WARNING: DO NOT bleed fuel lines on hot engine, as high exhaust temperatures could cause fire. Use care when bleeding fuel lines, as fuel is under extreme pressure and could penetrate skin, causing personal injury. Wear safety goggles and protective clothing when bleeding fuel lines.

WARNING: Relieve fuel system pressure prior to servicing any fuel system component.

HALOGEN BULBS

Halogen bulbs contain pressurized gas which may explode if overheated. DO NOT touch glass portion of bulb with bare hands. Eye protection should be worn when handling or working around halogen bulbs.

RADIATOR CAP

CAUTION: Always disconnect the fan motor when working near the radiator fan. The fan is temperature controlled and could start at any time even when the ignition key is in the OFF position. DO NOT loosen or remove radiator cap when cooling system is hot.

STARTING FLUID USE (TURBO DIESEL)

WARNING: DO NOT USE starting fluids (ether) or flammable liquids to aid the starting of a Cummins Turbo-Diesel. NEVER pour diesel fuel, flammable liquids or starting fluids into the air cleaner canister, air intake or turbocharger housing in an attempt to start the vehicle. A flash fire may result causing personal injury.

TRANSFER CASE

CAUTION: Both drive axles are disengaged when transmission gear is in Neutral position. Always set parking brake when leaving vehicle unattended.

CAUTION: Never attempt to engage Low range when vehicle is moving faster than 2-3 MPH (3-5 KM/H). Transfer case damage may result.

GASOLINES CONTAINING ALCOHOL

CAUTION: Exclusive use of gasohol is not recommended. Vehicle test results have shown that significant fuel system corrosion can result when gasohol is used exclusively. Fuel additives which are now being sold as octane enhancers are not recommended. Most of these products contain high concentrations of methanol.

WARRANTY INFORMATION

CAUTION: Due to the different warranties offered in various regions and the variety of after-market extended warranties available, please refer to the warranty package that came with the vehicle to verify all warranty options.

BASIC NEW CAR WARRANTY

Jeep Corporation warrants to the original purchaser that the vehicle is free from defects under normal use and service for 12 months or 12,000 miles, whichever comes first.

POWERTRAIN PROTECTION LIMITED WARRANTY

Begins at 12 months or 12,000 miles and lasts for 7 years or 70,000 miles, whichever comes first. Warranty covers Engine, Transmission, Transfer Case, and Drive Shaft/Drive Axle(s) for RWD & 4WD.

Items not covered include, normal scheduled maintenance, tune-ups, clutch adjustments, lack of proper maintenance, and vehicles on which the mileage cannot readily be determined. A 100.00 deductible on 2WD models and a 150.00 deductible on 4WD models applies to each repair visit.

Powertrain Warranty also covers cost of towing to nearest Jeep Dealer if vehicle cannot be driven due to failure of a covered powertrain part.

ANTI-CORROSION PERFORATION WARRANTY

Warrants the sheet metal parts of the vehicle against perforation (rust-through) due to corrosion. It covers any body sheet metal panel for unlimited mileage during the first 36 months. Outer-body sheet metal panels are covered for 7 years or 100,000 miles,

whichever occurs first.

EMISSION DEFECT WARRANTY (EXCEPT CALIFORNIA)

It warrants that vehicle meets Federal emissions standards in force at time of vehicle’s manufacture. Warranty covers the cost of repair or adjustment of any parts of vehicle’s emission control systems that are defective in material, workmanship or factory preparation, but ONLY IF the defect causes the vehicle to fail to meet Federal standards. Begins at warranty start date and lasts for 5 years or 50,000 miles, whichever occurs first.

EMISSION PERFORMANCE WARRANTY (EXCEPT CALIFORNIA)

It begins at warranty start date and lasts for 5 years or 50, 000 miles, whichever comes first. This warranty applies only under the following conditions:

* Vehicle failed a Federally-approved state or local emissions test.
* Vehicle has been maintained and operated properly up until the time of testing.
* Owner faces a penalty or other sanctions because of the vehicle’s failure to pass the local emissions test.

The following components and systems are covered: Carburetor Feedback Control System, Electronic Fuel Injection System, Air Cleaner Vapor Containment Door System, Electronic Spark Control, Electronic Control Module, Vapor Storage Canister and Controls, Deceleration Throttle Control, EGR Valve & Control System, Air Pump, Belt & Pulley, Air Injection Controls, PCV Valve, Catalytic Converter, Vacuum Hoses, Clamps, Fittings & Tubing used in these components and systems, Vacuum, Temperature, Altitude, Speed and Time-Sensitive Valves and Switches used in these components and systems.

EMISSION PERFORMANCE WARRANTY (CALIFORNIA)

If vehicle fails a Smog Check inspection, all necessary repairs and adjustments will be made by manufacturer to ensure that your vehicle passes the inspection. Warranty begins at warranty start date and lasts for a period of 3 years or 50,000 miles, whichever occurs first.

EMISSION DEFECTS WARRANTY (CALIFORNIA)

If any emission-related part on your vehicle is defective, the part will be repaired or replaced by manufacturer for a period of 3 years or 50,000 miles, whichever occurs first. Warranty begins at warranty start date and lasts for a period of 3 years or 50,000 miles, whichever occurs first.

The following emission-related parts are warranted for 7 years or 70,000 miles, whichever occurs first, and will be repaired or replaced by manufacturer if found to be defective in material or workmanship: Catalytic Converter, Intake Manifold, Carburetor, Throttle Body, Injectors, Fuel Tank, Exhaust Manifolds (4.0L).

FUSES & CIRCUIT BREAKERS

Fuse panel is located at the lower left side of dash on most models.

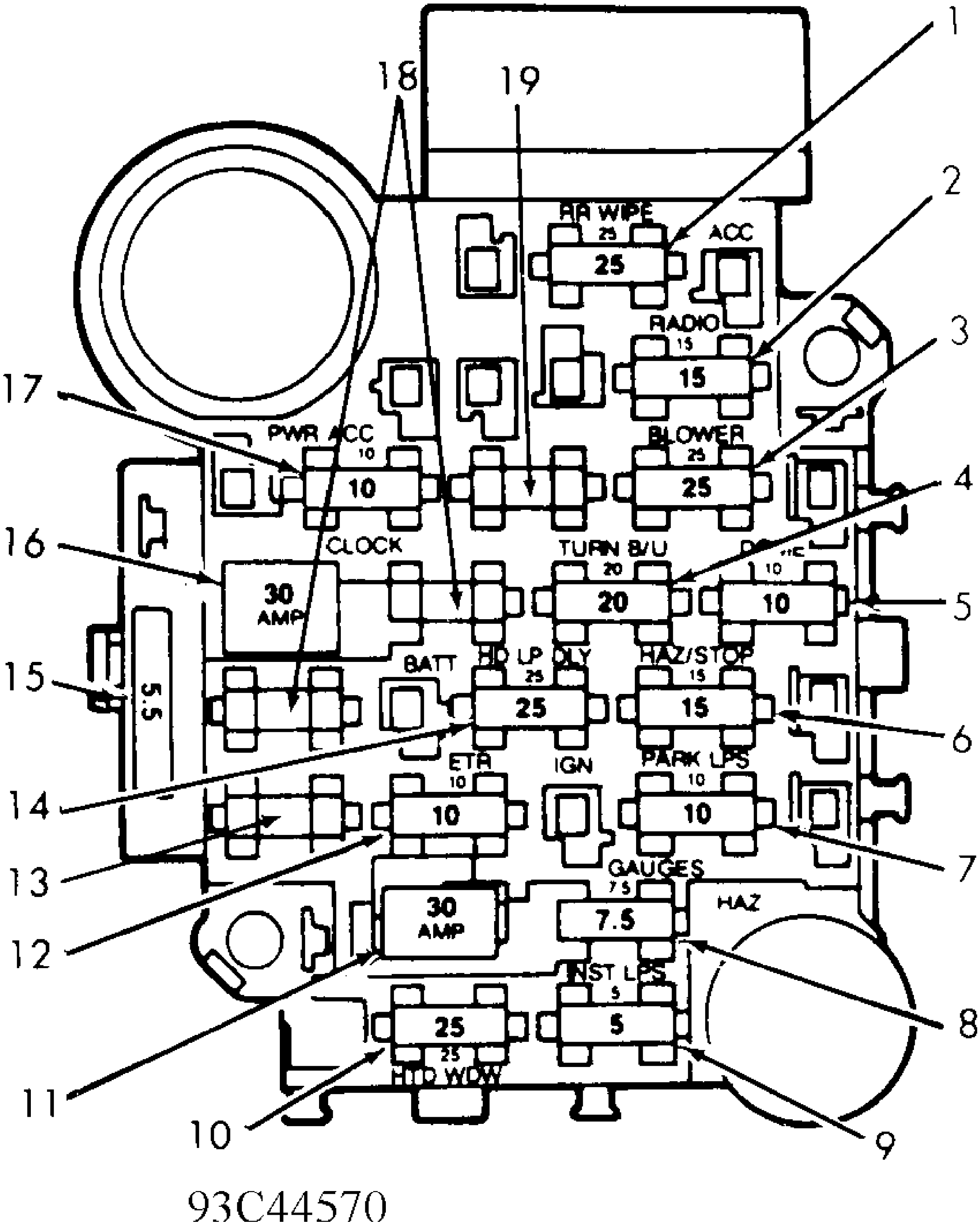


Fig. 12: Fuse Panel Identification
Courtesy of American Motors Corp.

Fuse & Circuit Breaker Identification

1 - 25 Amp
    Rear Washer/Wiper
2 - 15 Amp
    Radio, Cigarette Lighter
3 - 25 Amp
    Blower Motor
4 - 20 Amp
    Turn Signal, Back-Up Lights, Rear Window Defogger Relay
5 - 10 Amp
    Dome Light, Courtesy Lights, Glove Box Light, Cargo Light,
    Radio Memory, Power Mirrors, Teltak Connector
6 - 15 Amp
    Hazard Warning System, Stoplights
7 - 10 Amp
    Parking Lights, Headlight Warning Chime/Buzzer, Instrument
    Panel Light Dimmer
8 - 7.5 Amp
    Gauges, Instrument Cluster, Seat Belt Warning,
    Headlight Delay, Chime Module, Overhead Console
9 - 5 Amp
    Instrument Panel Illumination
10 - 25 Amp
    Rear Window Defogger
11 - 30 Amp (Circuit Breaker)
    Power Door Locks, Power Seats, Trailer Towing Wiring Harness
12 - 10 Amp
    ETR Radio, Power Antenna
13 - Not Used (1984-87)
    7.5 Amp (1988)
    Transmission Control Unit
14 - 25 Amp
    Headlight Delay, Horns, Security Alarm
15 - 5.5 Amp (Circuit Breaker)
    Front Wiper
16 - 30 Amp (Circuit Breaker)
    Power Windows
17 - 10 Amp
    Clock, Security Alarm (IGN)

MAINTENANCE REMINDER LIGHT RESET PROCEDURES

1988 Jeep Cherokee

1988-92 MAINTENANCE
Chrysler Motors Maintenance Reminder Lights

Jeep; Cherokee, Comanche, Wagoneer (1988-90), Wrangler

EMISSION MAINTENANCE INDICATOR LIGHT (1988-90)

Vehicles are equipped with an emission maintenance indicator light on instrument cluster. This light will come on one time at 82,500 miles to alert driver that emission service is required. At this time, oxygen sensor and PCV valve must be replaced and all other emission components should be inspected and serviced or replaced as necessary.

Indicator timer is located under dash, near accelerator pedal or to right of steering column. Timer cannot be reset. To turn off light, timer must be replaced or disconnected. Since timer and sensor are interdependent, if timer should fail prematurely, oxygen sensor should be replaced at same time to preserve correct replacement interval.

To replace timer on Cherokee, Comanche and Wagoneer models, remove cruise control module (if equipped). Remove timer mounting screws. Disconnect electrical connector. On Wrangler models, remove timer mounting screws. Disconnect electrical connector. On all models, install remaining components.

EMISSION MAINTENANCE INDICATOR LIGHT (1991-92)

Vehicles are equipped with an emission maintenance indicator light on instrument cluster. This light will come on one time at 82,500 miles to alert driver that emission service is required. At this time, oxygen sensor must be replaced and all other emission components should be inspected and serviced or replaced as necessary. Chrysler's Diagnostic Readout Box (DRB-II) tester is required to reset the emission maintenance indicator light.

Reset Procedure

Using DRB-II tester, access SELECT SYSTEMS. Select appropriate engine. Select with or without A/C. Select FUEL & IGNITION. Select ADJUSTMENTS. Select RESET EMR LIGHT. Reset EMR light. When DRB-II is finished resetting light, DRB-II display will read EMR LIGHT IS RESET.

METRIC CONVERSIONS

1988 Jeep Cherokee

GENERAL INFORMATION

METRIC CONVERSIONS

METRIC CONVERSIONS

Metric conversions are making life more difficult for the mechanic. In addition to doubling the number of tools required, metric-dimensioned nuts and bolts are used alongside English components in many new vehicles. The mechanic has to decide which tool to use, slowing down the job. The tool problem can be solved by trial and error, but some metric conversions aren't so simple. Converting temperature, lengths or volumes requires a calculator and conversion charts, or else a very nimble mind. Conversion charts are only part of the answer though, because they don't help you "think" metric, or "visualize" what you are converting. The following examples are intended to help you "see" metric sizes:

LENGTH

Meters are the standard unit of length in the metric system. The smaller units are 10ths (decimeter), 100ths (centimeter), and 1000ths (millimeter) of a meter. These common examples might help you to visualize the metric units:

* A meter is slightly longer than a yard (about 40 inches).
* An aspirin tablet is about one centimeter across (.4 inches).
* A millimeter is about the thickness of a dime.

VOLUME

Cubic meters and centimeters are used to measure volume, just as we normally think of cubic feet and inches. Liquid volume measurements include the liter and milliliter, like the English quarts or ounces.

* One teaspoon is about 4 cubic centimeters.
* A liter is about one quart.
* A liter is about 61 cubic inches.

WEIGHT

The metric weight system is based on the gram, with the most common unit being the kilogram (1000 grams). Our comparable units are ounces and pounds:

* A kilogram is about 2.2 pounds.
* An ounce is about 28 grams.

TORQUE

Torque is somewhat complicated. The term describes the amount of effort exerted to turn something. A chosen unit of weight or force is applied to a lever of standard length. The resulting leverage is called torque. In our standard system, we use the weight of one pound applied to a lever a foot long, resulting in the unit called a foot-pound. A smaller unit is the inch-pound (the lever is one inch long).

Metric units include the meter kilogram (lever one meter long with a kilogram of weight applied) and the Newton-meter (lever one

meter long with force of one Newton applied). Some conversions are:

* A meter kilogram is about 7.2 foot pounds.
* A foot pound is about 1.4 Newton-meters.
* A centimeter kilogram (cmkg) is equal to .9 inch pounds.

PRESSURE

Pressure is another complicated measurement. Pressure is described as a force or weight applied to a given area. Our common unit is pounds per square inch. Metric units can be expressed in several ways. One is the kilogram per square centimeter (kg/cm^2). Another unit of pressure is the Pascal (force of one Newton on an area of one square meter), which equals about 4 ounces on a square yard. Since this is a very small amount of pressure, we usually see the kiloPascal, or kPa (1000 Pascals). Another common automotive term for pressure is the bar (used by German manufacturers), which equals 10 Pascals. Thoroughly confused? Try the examples below:

* Atmospheric pressure at sea level is about 14.7 psi.
* Atmospheric pressure at sea level is about 1 bar.
* Atmospheric pressure at sea level is about 1 kg/cm^2.
* One pound per square inch is about 7 kPa.

CONVERSION FACTORS

CONVERSION FACTORS

TO CONVERT	TO	MULTIPLY BY
LENGTH		
Millimeters (mm)	Inches	.03937
Inches	Millimeters	25.4
Meters (M)	Feet	3.28084
Feet	Meters	.3048
Kilometers(Km)	Miles	.62137
AREA		
Square Centimeters (cm^2)	Square Inches	.155
Square Inches	Square Centimeters	6.45159
VOLUME		
Cubic Centimeters	Cubic Inches	.06103
Cubic Inches	Cubic Centimeters	16.38703
Liters	Cubic Inches	61.025
Cubic Inches	Liters	.01639
Liters	Quarts	1.05672
Quarts	Liters	.94633
Liters	Pints	2.11344
Pints	Liters	.47317
Liters	Ounces	33.81497
Ounces	Liters	.02957
WEIGHT		
Grams	Ounces	.03527
Ounces	Grams	28.34953
Kilograms	Pounds	2.20462
Pounds	Kilograms	.45359
WORK		
Centimeter Kilograms	Inch Pounds	.8676
Pounds/Sq. Inch	Kilograms/Sq.Centimeter	.07031
Bar	Pounds/Sq. Inch	14.504

Pounds/Sq. Inch	Bar	.06895
Atmosphere	Pounds/Sq. Inch	14.696
Pounds/Sq. Inch	Atmosphere	.06805
TEMPERATURE		
Centigrade Degrees	Fahrenheit Degrees	(°Cx(9)/5)+32
Fahrenheit Degrees	Centigrade Degrees	(°F-32)x(5)/9

CONVERSION FACTORS (Cont.)

INCHES	DECIMALS	mm
1/64	.016	.397
1/32	.031	.794
3/64	.047	1.191
1/16	.063	1.588
5/64	.078	1.984
3/32	.094	2.381
7/64	.109	2.778
1/8	.125	3.175
9/64	.141	3.572
5/32	.156	3.969
11/64	.172	4.366
3/16	.188	4.763
13/64	.203	5.159
7/32	.219	5.556
15/64	.234	5.953
1/4	.250	6.350
17/64	.266	6.747
9/32	.281	7.144
19/64	.297	7.541
5/16	.313	7.938
21/64	.328	8.334
11/32	.344	8.731
23/64	.359	9.128
3/8	.375	9.525
25/64	.391	9.992
13/32	.406	10.319
27/64	.422	10.716
7/16	.438	11.113
29/64	.453	11.509
15/32	.469	11.906
31/64	.484	12.303
1/2	.500	12.700
33/64	.516	13.097
17/32	.531	13.494
35/64	.547	13.891
9/16	.563	14.288
37/64	.578	14.684
19/32	.594	15.081
39/64	.609	15.478
5/8	.625	15.875
41/64	.641	16.272
21/32	.656	16.669
43/64	.672	17.066
11/16	.687	17.463
45/64	.703	17.859
23/32	.719	18.256
47/64	.734	18.653
3/4	.750	19.050
49/64	.766	19.447

25/32	.781	19.844
51/64	.797	20.241
13/16	.813	20.638
53/64	.828	21.034
27/32	.844	21.431
55/64	.859	21.828
7/8	.875	22.225
57/64	.891	22.622
29/32	.906	23.019
59/64	.922	23.416
15/16	.938	23.813
61/64	.953	24.209
31/32	.969	24.606
63/64	.984	25.003
1	1.000	25.400

MIRRORS - POWER

1988 Jeep Cherokee

1988 Power Mirrors
JEEP

DESCRIPTION

Outside power rear view mirrors consist of door-mounted mirrors with internal motor drive and backing plate. The Ford electronic day/night mirror will change from normal to non-glare position when glare reaches mirror. The non-glare functions only at night.

TESTING

Mirror Motors & Switches

1) Ensure fuse is okay by operating interior lights. If neither mirror operates, check for battery voltage at power mirror switch assembly. Connect a voltmeter between terminal "G" (Red with White stripe) and ground. If battery voltage is present, connect voltmeter between terminals "G" and "F" (Black). If battery voltage is not present, check circuit at Red with White stripe wire and Black wire.

2) If one mirror does not operate, connect a voltmeter across power mirror switch assembly terminals. See Fig. 1. Voltage will be present when control switch and mirror select switch are operated for that motor.

Terminal Wire Colors	Motor	Voltage
A YEL and E BLUE	LH Mirror, Up-Down	Battery
B WHT and E BLUE	LH Mirror Left-Right	Battery
D YEL W/TR and E BLU	RH Mirror, Up-Down	Battery
C WHT W/TR and E BLU	RH Mirror, Left-Right	Battery

Fig. 1: Jeep Switch Assembly Check Chart
Courtesy of American Motors/Jeep Corp.

3) If voltage is present but mirror does not operate, check motor and wiring. If voltage is not present when 2 switches are on,

replace switch assembly.

POWER STEERING GENERAL SERVICING

1988 Jeep Cherokee

1988 STEERING
Jeep Power Steering General Servicing

Cherokee, Comanche, Grand Wagoneer, Pickup, Wagoneer, Wrangler

LUBRICATION

SERVICE INTERVALS

Check fluid at every oil change.

CHECKING FLUID LEVEL

Check fluid level with engine stopped and fluid hot or cold. Fluid level must be at "FULL-HOT" or "FULL-COLD" mark on dipstick. On models with remote reservoir, keep fluid level 0.5-1.0" from top of reservoir with wheels turned fully to left.

RECOMMENDED FLUID TABLE

Application	Part Number
Jeep	8993342

REFILLING & BLEEDING SYSTEM

1) Fill reservoir to correct level. Operate engine until fluid reaches normal operating temperature. Stop engine. Add fluid (if necessary). Turn wheels to full left position. Add fluid to reservoir to fill to "FULL-COLD" mark on dipstick.

2) Start and operate engine at fast idle. Recheck reservoir level. Add to "FULL-COLD" mark on dipstick. Turn wheels from side to side without contacting stops. Maintain fluid level just above pump body.

3) When air is removed, return wheels to straight-ahead position. Operate engine 2-3 minutes. Stop engine. Road test vehicle. Recheck fluid level. Level should be at "FULL-HOT" position after system has stabilized. Add fluid (if necessary). DO NOT overfill.

BELT TENSION (Tension in Lbs. Using Boroughs Tension Gauge)

Application	New Belt	Used Belt
Jeep	(1) 125-155	90-115

(1) - Cherokee, Comanche and Wagoneer is 120-140 lbs.

TROUBLE SHOOTING

Refer to TROUBLE SHOOTING - BASIC PROCEDURES article in the GENERAL TROUBLE SHOOTING section.

TESTING

PREPARATION

1) With belt tension correct, disconnect power steering pump pressure hose. Keep hose end raised to prevent fluid loss. Connect pressure hose of gauge to power steering pump fitting. Connect other hose from valve side of tester to steering gear inlet.

2) Open valve. Run engine until fluid reaches normal operating temperature of 170°F (77°C). Check fluid level. Add fluid (if necessary).

PRESSURE TEST

1) Note pressure reading with valve open and engine idling. Pressure should be 80-125 psi (5.6-8.8 kg/cm²).

2) If pressure is above 200 psi (14.1 kg/cm²), check hoses for restrictions and poppet valve (Saginaw gears) for proper assembly.

3) Close gate valve completely and reopen 3 times. Record highest reading each time. DO NOT close valve for more than 5 seconds. If pressure is less than specification, clean or replace flow control valve in pump. If pressures are still low, replace pump.

4) If readings are within specifications and within 50 psi (3.5 kg/cm²) of each other, pump is operating properly. Refer to the PRESSURE TEST SPECIFICATIONS table. If pressures are high, but do not repeat within 50 psi (3.5 kg/cm²), flow control valve in pump is sticking. Remove flow control valve. Clean or replace flow control valve.

5) If pump is within specifications, open valve and turn steering wheel from right to left stops. Record pressure. DO NOT hold wheel against stops more than 5 seconds.

6) Pressure should measure the same as specified. See the PRESSURE TEST SPECIFICATIONS table. If pressure is low, steering gear is leaking internally and must be overhauled.

7) Turn steering wheel from left to right with engine idling at 600-800 RPM. See PRESSURE TEST SPECIFICATIONS table.

8) If pressure is low, momentarily close valve. If pressure is less than specified, pump is faulty. If pressure is within specification but was low at previous reading, steering gear is faulty.

PRESSURE TEST SPECIFICATIONS TABLE

Application	Idle: psi (kg/cm²)	Relief: psi (kg/cm²)
Jeep	80-125 (6-9)	1400-1500 (98-105)

POWER STEERING PUMP

1988 Jeep Cherokee

1988 STEERING
Jeep Power Steering Pumps - Saginaw Vane-Type

Cherokee, Comanche, Grand Wagoneer, Pickup, Wagoneer, Wrangler

DESCRIPTION

Saginaw vane-type power steering pump can be identified by "ham-shaped" fluid reservoir can. Rectangular pumping vanes carried by a shaft driven rotor move fluid from intake to pressure cavities of cam ring.

Centrifugal force throws vanes against inside surface of cam ring to pick up residual oil. As more oil is picked up, it is forced into cavities of thrust plate, into 2 cross-over holes in cam ring and pressure plate and into a high pressure area between pressure plate and housing end plate.

Filling the high pressure area causes oil to flow under vanes in slots of rotor. This forces vanes to follow inside oval surface of cam ring. As vanes rotate to small area of cam ring, oil is forced out from between vanes.

TROUBLE SHOOTING

Refer to TROUBLE SHOOTING - BASIC PROCEDURES article in the GENERAL TROUBLE SHOOTING section.

LUBRICATION & TESTING

See POWER STEERING GENERAL SERVICING article in the STEERING section.

REMOVAL & INSTALLATION

POWER STEERING PUMP

Removal & Installation

1) Loosen pump adjusting bolt (or nut) and pump mounting bolts. Remove pump drive belt. Disconnect pressure and return hoses from pump. Cap ends to prevent loss of fluid or contamination.

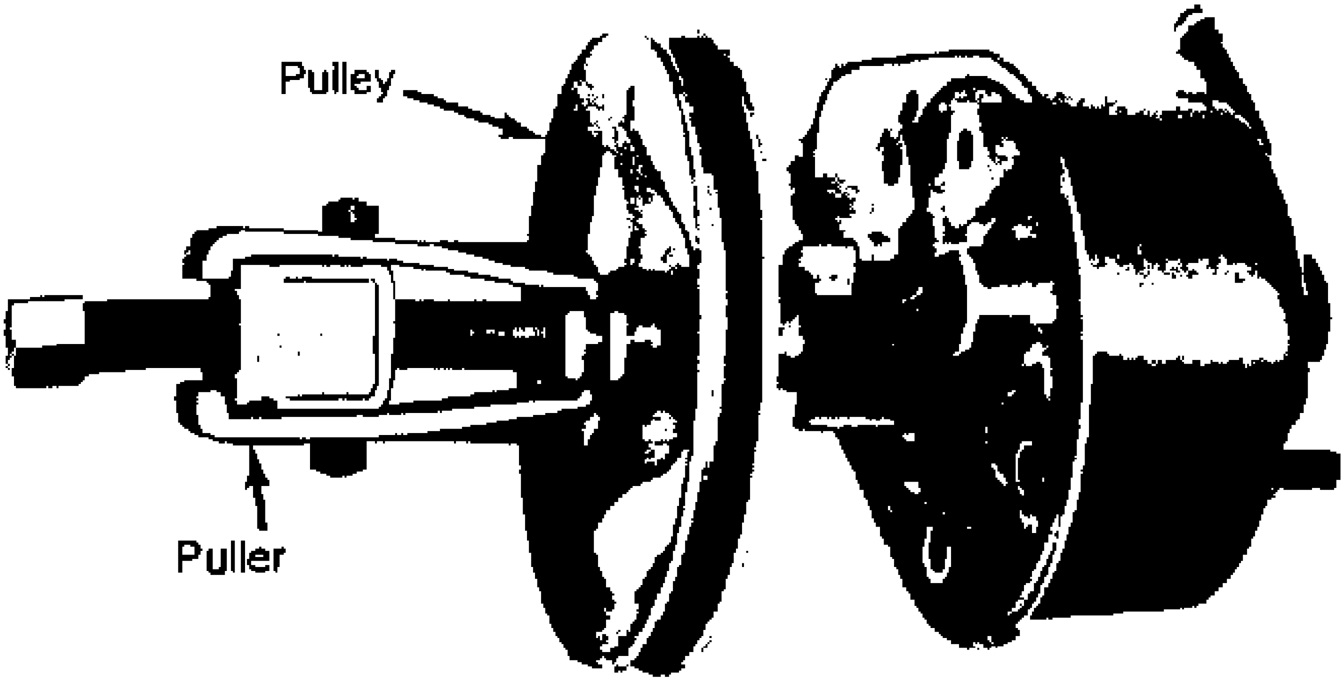
2) Remove pump bracket-to-engine bolts. Remove pump, pulley and mounting bracket as an assembly. To install, reverse removal procedure. Bleed system.

OVERHAUL

CAUTION: When clamping pump in vise, be careful not to exert excessive force on front hub or pump. DO NOT use hammer to remove pulley.

DISASSEMBLY

1) Drain pump reservoir. Clean exterior of unit. Remove mounting bracket(s). Using a puller, withdraw pulley from shaft. See Fig. 1.

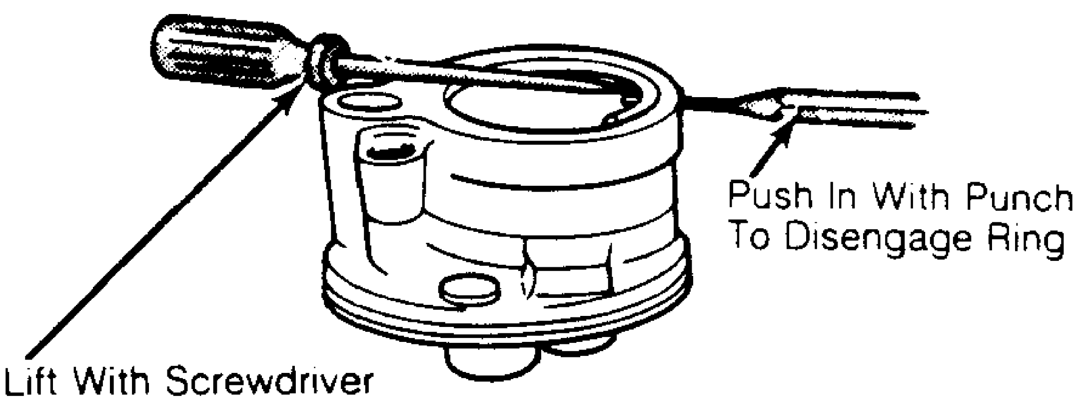


30342
Fig. 1: Removing Pump Pulley

2) Clamp pump, with shaft pointing down and at the square boss of the shaft housing, into a soft-jawed vise. Remove pressure line union and "O" ring. Remove reservoir retaining studs.

3) Tap against filler tube with plastic hammer to loosen reservoir on pump body. Remove reservoir from body. Remove and discard "O" rings.

4) Using 1/8" punch, tap end plate retaining ring around until end of ring is near hole in pump body. Inserting punch in hole, disengage ring from groove in pump bore. Using a screwdriver, pry ring from body. See Fig. 2.



30341
Fig. 2: Removing Pump End Plate Retaining Ring

5) Tap end plate with a soft-faced hammer to loosen. Spring tension should push plate up. Remove spring. Remove pump from vise.

6) Invert pump and place on flat surface. Using soft-faced

hammer, tap end of drive shaft to loosen pressure plate, rotor, and thrust plate assembly from body.

7) Lift pump body off rotor assembly. Flow control valve and spring should slide out of bore. Remove and discard end plate and pressure plate "O" rings.

8) Using a screwdriver, pry drive shaft oil seal from body. Lift pressure plate and cam ring from rotor. Remove rotor vanes.

9) Clamp drive shaft in soft-jawed vise, with rotor and thrust plate facing up. Remove rotor lock ring from shaft. Use care not to nick shaft or rotor. Slide rotor and thrust plate off shaft. Remove shaft from vise.

CLEANING & INSPECTION

1) Clean all pump components (except drive shaft seal) in clean solvent. Blow dry. Inspect flow control valve assembly for wear, scoring, burrs or other damage. Inspect seal bore for burrs, nicks, or score marks that would allow oil to by-pass outer seal surface.

2) Check all machined surfaces of body for scratches or burrs which might allow leaks. Check "O" ring mating surfaces. Inspect pump body drive shaft bushing for excessive wear.

3) If replacement is required, replace pump body and bushing as an assembly. Inspect end cover "O" ring mating surface for nicks and burrs. Polish with oil stone (if necessary).

4) Inspect rotor ring for roughness or irregularities. Use oil stone to correct minor irregularities. Replace ring if outside cam surface is worn or scored. Check thrust plate and pressure plate for scoring and wear.

5) To remove light scoring, lap with crocus cloth until surface is smooth and flat. Clean thoroughly. Check that vanes slide freely but fit snugly into slots.

6) If vanes are loose in slots, replace rotor and/or vanes. Scoring on rotor may be removed by lapping with crocus cloth. Clean thoroughly.

REASSEMBLY

1) Lubricate all "O" rings, seals and seal surfaces with power steering fluid. On Jeeps, lubricate "O" rings with petroleum jelly. With pump on flat surface, drive new shaft seal in until it bottoms on bore shoulder.

2) Clamp body in vise with shaft pointing down. Install end plate and pressure plate "O" rings on body. Install body to reservoir "O" rings. Install on pump body.

3) Place shaft, splined end up, in soft-jawed vise. Install thrust plate on shaft with smooth, ported side up. Slide rotor, counter bore down, over splines.

4) Install new rotor lock ring. Ensure ring is seated in groove. Install 2 dowel pins into holes in pump cavity. Insert drive shaft, rotor, and thrust plate assembly into pump cavity. Align locating holes with dowel pins.

5) Slide cam ring over rotor and onto dowel pins, with arrow on ring facing toward rear of housing. Install vanes in rotor slots with radius edge facing out towards cam ring inner surface. Position pressure plate on dowel pins with circular spring depression facing rear of housing.

6) Using a 1 1/4" socket in groove of pressure plate, press down on socket with both thumbs to seat assembly on "O" ring in pump cavity. Place spring in groove in pressure plate. Place end cover lip edge over spring.

7) Using thumb or arbor press, press end cover down below retaining ring groove. Seat retaining ring in groove. Take care to prevent cocking end cover in bore or distorting assembly.

8) Using a punch, tap retaining ring ends around in groove until opening is opposite flow control valve bore. This ensures maximum retention of retaining ring.

9) Install new "O" rings to reservoir, mounting studs, and flow control valve. Place reservoir on pump body. Align mounting stud holes. Install studs.

10) Using a soft-faced hammer, tap reservoir down on pump. Install flow control valve spring and valve assembly slotted end up. Install new "O" ring on pressure hose fitting uppermost groove.

CAUTION: DO NOT install pressure hose "O" ring in lower groove. This will restrict relief outlet orifice.

11) Install pressure hose fitting. Tighten mounting studs. Tighten hose fitting. Remove pump from vise. Install mounting bracket and pulley.

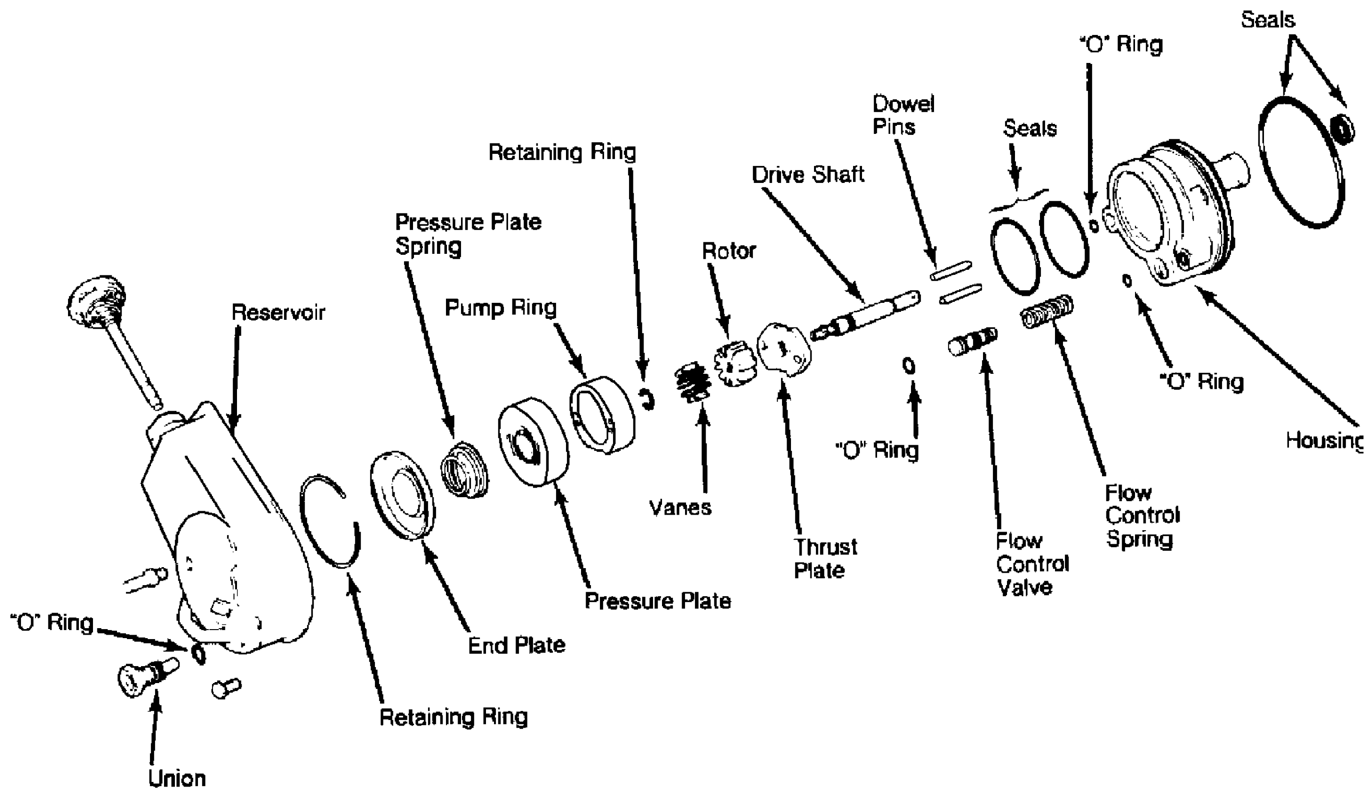


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Fig. 3: Exploded View of Power Steering Pump

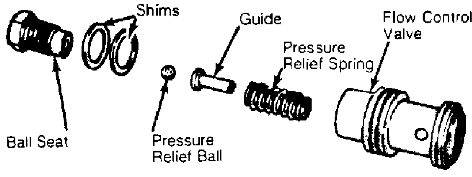

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Fig. 4: Exploded View of Control Valve Assembly

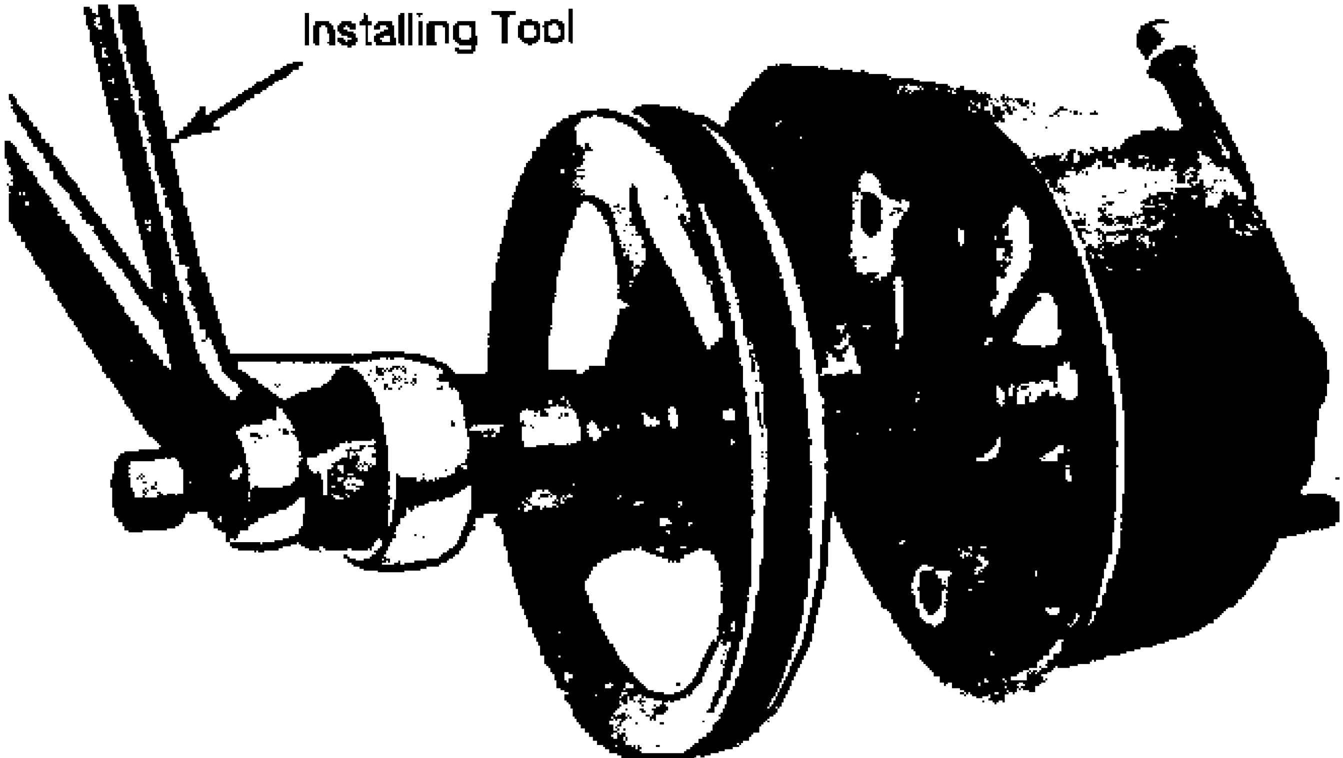

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Fig. 5: Installing Pump Pulley

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS TABLE

Application	Ft. Lbs. (N.m)
Gear End Hose Fittings	20 (27)
Pump End Hose Fittings	20 (27)
Bracket Bolts	35 (48)

POWER WINDOWS

1988 Jeep Cherokee

1988 Power Windows
JEEP SIDE & TAILGATE WINDOWS

Cherokee, Comanche, Grand Wagoneer, Wagoneer

DESCRIPTION

All models have a tape-driven window regulator system in the side doors, and a mechanical regulator in rear door of Grand Wagoneer. On Grand Wagoneer, the tailgate window operates on 2 circuits, from an instrument panel switch or an external key switch at the tailgate. Side windows are operated by individual switches at each door, or by a complete set of control switches at the instrument panel or drivers door. The system is protected by a 30 amp circuit breaker in the fuse panel.

TESTING

NOTE: Ensure instrument panel tailgate switch is properly grounded as motor grounds through switch. The electric tailgate and defogger switch are serviced as an assembly.

INSTRUMENT PANEL TAILGATE SWITCH

Grand Wagoneer

1) Turn ignition on. Using a 12-volt test light, connect one end of test light to ground and probe Red wire. If test light does not glow, repair feed circuit.

2) If test light glows, probe Brown wire with switch in "UP" position. If test light does not glow, replace switch. If test light glows, move switch to "DOWN" position and probe Tan wire. If test light does not glow, replace switch. If test light glows, check tailgate window switch.

TAILGATE WINDOW SWITCH

Grand Wagoneer

1) Using a 12-volt test light, connect one end of test light to ground and probe Red wire of tailgate window switch. If test light does not glow, repair feed circuit.

2) If test light glows, probe Tan wire. Turn tailgate switch to "DOWN" position. If test light does not glow, replace switch. If test light glows, probe Brown wire. Turn tailgate switch to "UP" position.

3) If test light does not glow, replace switch. If test light glows, check tailgate window safety switch.

TAILGATE WINDOW SAFETY SWITCH

Grand Wagoneer

1) Using a 12-volt test light, connect one end of test light to ground and probe Brown wire of safety switch. Turn tailgate switch to "UP" position. If test light glows, voltage is present at switch. If test light does not glow, check feed circuit and repair as necessary.

2) Probe Brown wire. Turn tailgate switch to "UP" position and close safety switch. If test light does not glow, replace switch.

If test light glows, check tailgate window motor.

TAILGATE WINDOW MOTOR

Grand Wagoneer

1) Using a 12-volt test light, connect one end of test light to ground and probe Tan wire at motor. Close safety switch and turn tailgate window switch to "DOWN" position. If test light glows and motor does not operate, replace motor. If test light does not glow, check feed circuit to motor and repair as necessary.

2) Probe Brown wire at motor. Close safety switch and turn tailgate window switch to "UP" position. If test light glows and motor does not operate, replace motor. If test light does not glow, check feed circuit to motor and repair as necessary.

SIDE WINDOW MASTER SWITCH CIRCUIT

1) Remove escutcheon and housing from master switch. Separate terminal plate by releasing retainer hooks to expose terminal ends. Turn ignition on.

2) Using a 12-volt test light, connect one lead to Black wire and other lead to Red terminal. Repeat test at second Black wire. If test light does not glow in either test, remove lead to Black terminal and connect to chassis ground.

3) If test light glows, an open exists between master switch and ground. If test light does not glow, it indicates a defective circuit breaker or an opening in the Red wire from circuit breaker to master switch.

SIDE WINDOW CONTROL SWITCH & MOTOR TEST

Grand Wagoneer

1) Connect test light between terminals of Orange and Yellow wires. Operate control switch up and down. If test light glows in both switch positions, wires, individual door and master switches are not defective.

2) Disconnect White and Green motor leads at terminal plate, and connect to Green and White leads. Operate master switch. If window goes up and down, motor is okay, but switch is defective. If motor does not operate, remove trim panel and check connections and leads to motor. If motor operates, switch is defective.

SIDE WINDOW MOTOR

Connect test battery positive lead to one of the motor terminals. Connect negative lead to other terminal. Motor should rotate in one direction to go up or down. Reverse battery leads, motor should rotate in opposite direction. If window does not move, replace motor.

SWITCH VOLTAGE TEST

1) Turn ignition on. Remove switch from trim panel. Disconnect terminal block on wiring harness from switch body. Connect one lead of test light to Red wire terminal and other end to ground.

2) If test light glows, wiring between battery and switch is functional. Check continuity in Black wire (ground). If test light does not glow, check circuit breaker. If okay, check for a broken wire.

SWITCH UP & SWITCH DOWN TEST

1) Connect a jumper wire between Red lead (Violet on Cherokee, Comanche and Wagoneer) and switch "UP" terminal. Connect a second jumper wire between switch ground terminal and "DOWN" terminal. This will test up operation of switch.

2) If motor runs, connect switch to multiple connector and operate switch. If motor fails to run, replace switch. Test all switches in this manner.

3) To test down operation of switch, connect first jumper wire between Red (Violet) lead and switch "DOWN" terminal, and second jumper wire between switch ground terminal and "UP" terminal. Repeat tests on all switches. Results are the same as up test.

Connector/ Terminal Wire Color	Window Switch & Window Motor	Voltage
C284-CV LT BLU and C284-DV YEL	LH Front	Battery
C284-CY TAN W/TR and C284-DY ORN W/TR	LH Rear	Battery
C284A-EV BRN and C284A-FV ORN	RH Front	Battery
C284A-EY LT BLU W/TR and C284A-FY YEL W/TR	RH Rear	Battery

Fig. 1: Switch Assembly Check Chart Cherokee & Wagoneer

REMOVAL & INSTALLATION

TAILGATE WINDOW REGULATOR & MOTOR

Removal (Grand Wagoneer)

1) Remove carpet (if equipped) and tailgate access cover. Remove retainers attaching regulator arms to channel. Disengage regulator arm pins from channel, and raise glass.

2) Carefully support glass in raised position. Disconnect wiring harness from safety switch. If regulator attaching screws are covered by sector gears, place a jumper wire between terminals of safety switch connector.

NOTE: If regulator attaching screws are accessible, remove regulator attaching screws and regulator.

3) Place key in tailgate switch and operate motor until regulator attaching screws are accessible. Hold regulator in this position, and wedge a screw between meshing teeth.

4) Remove regulator attaching screws and regulator. Using a large screwdriver, release spring tension from tension bracket. Remove motor attaching screws and motor.

Installation

To install, reverse removal procedure.

SIDE WINDOW MASTER SWITCH

Removal

1) Disconnect battery negative cable. Remove retaining screws and escutcheon. Remove switch housing screws.

2) Pull switch out to expose wires. Disconnect terminal plate from switch. Depress retainer clips through holes in switch housing, and remove switch.

Installation

To install, reverse removal procedure.

FRONT & REAR DOOR REGULATORS & MOTORS

Removal

1) Raise window half way up. Disconnect battery negative cable. Remove door trim panel and water shield.

2) Insert a drift punch into hole in door inner panel, or use masking tape to hold window half way up. Remove regulator arm retainer clip, and remove arm from bottom window channel.

3) Disconnect wires from motor. Remove inner door panel-to-regulator nuts and bolts. Remove regulator and motor assembly.

Installation

To install, reverse removal procedure.

PRE-ALIGNMENT CHECKS

1988 Jeep Cherokee

Wheel Alignment
PRE-ALIGNMENT INSPECTION PROCEDURES

PRE-ALIGNMENT CHECKS

Before making wheel alignment adjustment, perform the following checks:

1) Tires should be equal in size and runout must not be excessive. Tires and wheels should be in balance, and inflated to manufacturer's specifications.

2) Wheel bearings must be properly adjusted. Steering linkage and suspension must not have excessive looseness. Check for wear in tie rod ends and ball joints.

3) Steering gear box must not have excessive play. Check and adjust to manufacturer's specifications.

4) Vehicle must be at curb height with full fuel load and spare tire in vehicle. No extra load should be on vehicle.

5) Vehicle must be level with floor and with suspension settled. Jounce front and rear of vehicle several times and allow it to settle to normal curb height.

6) If steering wheel is not centered with front wheels in straight-ahead position, correct by shortening one tie rod adjusting sleeve and lengthening opposite sleeve equal amounts.

7) Ensure wheel lug nuts are tightened to torque specifications.

PVC & CRANKCASE VENTILATION SYSTEM

1988 Jeep Cherokee

1987-89 Crankcase Ventilation
PCV AND CCV SYSTEMS

Jeep

DESCRIPTION

Crankcase ventilation systems are designed to prevent contaminating hydrocarbons from escaping to the atmosphere. This is accomplished by routing vapors from the crankcase through a vacuum-controlled ventilating valve (PCV Valve) into the intake manifold. In the intake manifold, the crankcase vapors mix with the air/fuel mixture and are burned in the combustion process. PCV systems are used on all 4.2L and 5.9L engines. 2.5L and 4.0L engines do not employ PCV systems, instead they are equipped with a Crankcase Ventilation System (CCV). The CCV system performs the same function as a conventional PCV system, but does not use a vacuum controlled valve.

OPERATION

PCV SYSTEM

Air is supplied to the crankcase ventilation system through a crankcase ventilating filter assembly, located in air cleaner housing or on rocker arm cover.

When engine is operating, fresh air enters crankcase ventilation system through the air cleaner and filter.

Air then flows into the rocker arm cover and valve compartment. It combines with blow-by gas and unburned air/fuel mixture and burns in combustion chamber. See Fig. 1.

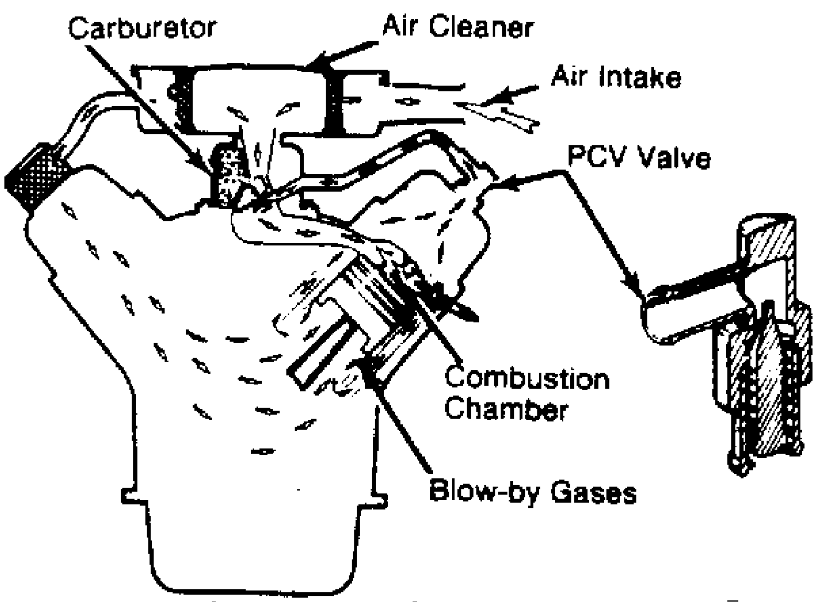


Fig. 1: Typical Crankcase Ventilation System

Ventilator valve is held closed by spring pressure when engine is not running. See Fig. 2. This prevents accumulation of hydrocarbon fumes from collecting in intake manifold, which could

result in hard starting.

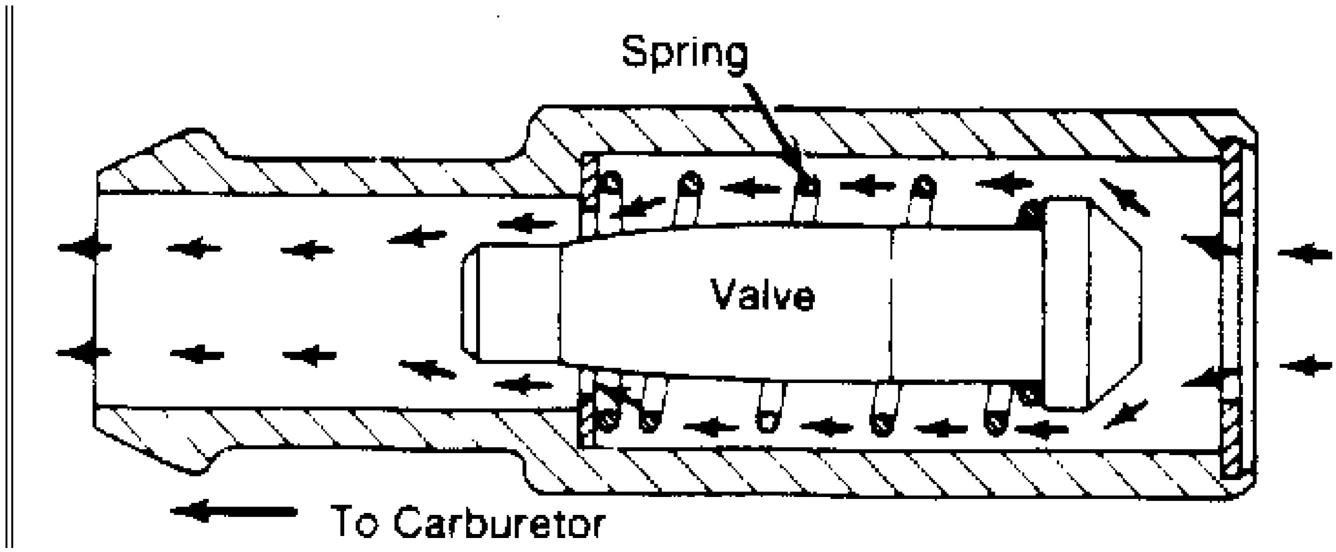


Fig. 2: Typical PCV Valve & Airflow

When engine is started, manifold vacuum pulls valve open against spring pressure. As long as there is engine vacuum, the valve floats, permitting crankcase fumes to enter intake manifold.

A baffle in rocker arm cover prevents oil from being drawn into intake manifold through ventilator valve.

If the engine backfires, the ventilator valve will close. This will prevent ignition of fumes in crankcase.

During certain engine operations, more blow-by is created than ventilator valve can handle. Excess blow-by is returned to air cleaner and carburetor through rocker arm cover and breather assembly. It is then burned in the combustion chamber.

A breather assembly acts as separator to keep oil from being drawn into air cleaner during this operation.

CCV SYSTEM

As stated above, the CCV system performs the same function as a conventional PCV system, but does not use a vacuum controlled valve.

A molded vacuum tube connects manifold vacuum to a grommet on top of the cylinder head cover at the dash panel end. The grommet contains a metered orifice of a calibrated size that meters the amount of crankcase vapors drawn out of the engine. A fresh air supply hose from the air cleaner is also connected to the front of the cylinder head cover on 4.0L engines and to the rear of the cover on 2.5L engines.

When the engine is operating, fresh air enters the engine and mixes with crankcase vapors. Manifold vacuum draws the vapor/air mixture through the metered orifice and into the intake manifold. The vapors are consumed during combustion.

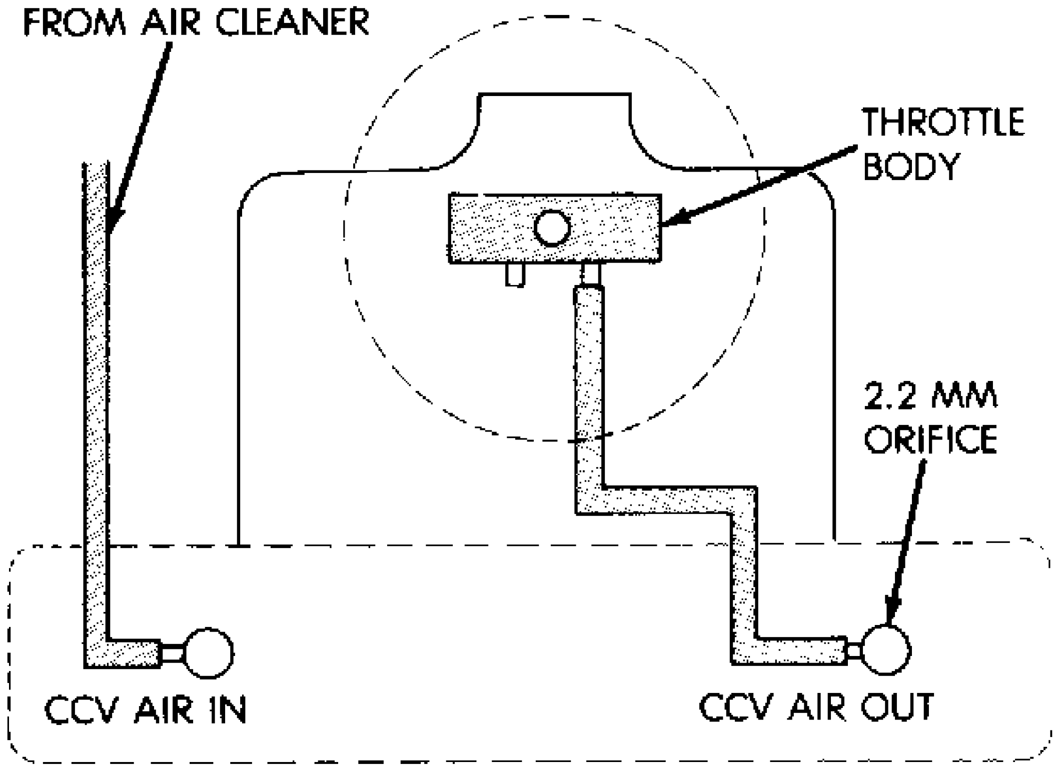


Fig. 3: CCV System 2.5L Engine

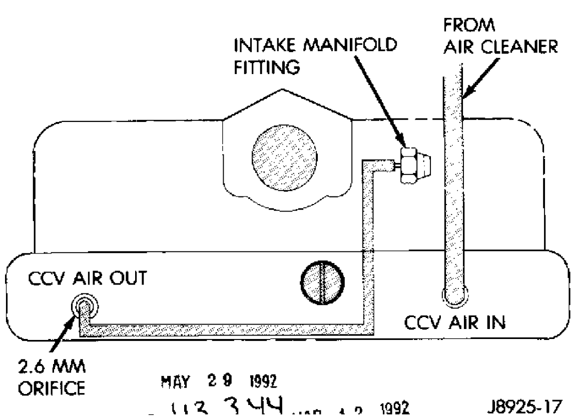


Fig. 4: CCV System 4.0L Engine

TESTING

To test crankcase ventilation system, start engine and allow it to reach normal operating temperature. Make sure engine is idling at normal curb idle, and perform following checks:

1) Remove PCV valve from its mounting. If valve is functioning properly, hissing noise will be heard as air passes through it. Strong vacuum should be felt when your finger is placed over valve inlet.

2) While finger is over inlet, check for presence of vacuum leaks in hose line and at all connections. Reinstall PCV valve, remove crankcase air inlet hose at air cleaner.

3) Loosely hold piece of stiff paper over opening at end of inlet hose. Paper should be sucked against hose opening with noticeable force after sufficient time has elapsed for crankcase pressure to lower (usually about a minute). For final check, stop engine, remove PCV valve and shake it. Metallic clicking noise should be heard, indicating valve is free.

4) If system passes both engine running and stopped tests, it is functioning properly. No further tests are required. If it has failed either test, replace appropriate components and retest. If it does not pass on second try, clean system.

MAINTENANCE

Engine may idle slow or rough due to clogged ventilator valve or system. Therefore, never adjust carburetor idle without first checking valve and system.

If ventilator valve or system becomes clogged, all crankcase ventilation will stop, and serious engine damage could result.

Although following manufacturers' service procedures give specific intervals, it is recommended the crankcase ventilation system be checked more frequently if vehicle is operated under severe conditions (extreme dust, prolonged idling, trailer hauling or short trips in cold weather).

PCV VALVE

Replace PCV valve every 30,000 miles. Valve is located on rocker arm cover of 4-cylinder, 6-cylinder and V6 models and on intake manifold of V8 models.

FILTER ELEMENT

Clean filter element every 30,000 miles. Filter is located inside air cleaner of 4-cylinder, 6-cylinder and V6 models and in oil filler cap of V8 models.

RECALL 561 - 4.0L ENG. FED. VEHICLES - OXYGEN SENSOR

1988 Jeep Cherokee

EMISSION RECALL BULLETIN

EMISSIONS RECALL #561 - OXYGEN SENSOR

Model(s): 1987-90 (XJ) Jeep Cherokee, Wagoneer
1987-90 (MJ) Jeep Comanche
Bulletin No.: 561
Date: October, 1993

NOTE: This is an Emission Recall bulletin.

VEHICLES AFFECTED

1987-90 Jeep Cherokee and Wagoneer (XJ); and Comanche (MJ) vehicles equipped with a 4.0L engine and located outside of California.

SERVICE INFORMATION

Failure of the oxygen sensor on the listed models, may cause a vehicle to be in violation of Federal Emissions Standards. To correct the condition, the oxygen sensor must be replaced with an improved design sensor.

Details of this service action are explained in the following sections.

SERVICE PROCEDURE VIDEOTAPE

No videotape of the service procedure for this recall will be provided.

DEALER NOTIFICATION & VEHICLE LIST

INVOLVED DEALERS

Each dealer to whom involved vehicles were invoiced (or the current dealer at the same street address) will receive a copy of this dealer recall notification letter and a list of the involved vehicles by first class mail.

The Vehicle List is arranged in Vehicle Identification Number (VIN) sequence. Owners known to Chrysler are also listed. The lists are for dealer reference in arranging for service of involved vehicles.

ALL DEALERS

Each Jeep & Eagle dealer will receive a copy of this dealer recall notification letter by first class mail.

DIAL SYSTEM FUNCTION 70

All involved vehicles will be entered to DIAL System Function 70 at the time of recall implementation for dealer inquiry by VIN as needed.

PARTS INFORMATION

IMPORTANT: A quantity of parts will be distributed initially and billed to all involved dealers. This quantity will cover a portion of the total vehicles involved. Additional parts will ba supplied as indicated in the Special Parts Supply Message with this notification letter.

Each involved dealer, to whom vehicles in the recall were invoiced (or the current dealer at the same street address), will receive enough Oxygen Sensor Packages, Recall P/N C3905610, to service 25% of those vehicles (minimum of 5 and maximum of 20 packages).

Each uninvolved dealer will receive 5 parts packages to service vehicles upon request.

Each parts package contains the following components:

PARTS INFORMATION

PARTS INFORMATION TABLE

Description	Qty.
Oxygen Sensor	1
Instruction Sheet	1

OWNER NOTIFICATION & SERVICE SCHEDULING

All involved vehicle owners known to Chrysler are being notified of the service requirement by first class mail. They are requested to schedule appointments for the service with their dealers at the earliest possible date. A copy of the CUSTOMER NOTIFICATION LETTER is in this bulletin.

Enclosed with each owner notification is an Owner Notification Form. The involved vehicle and recall are identified on the form for owner or dealer reference as needed.

SERVICE PROCEDURE

A. OXYGEN SENSOR INSPECTION

1. Raise Vehicle on a hoist and locate oxygen sensor in exhaust manifold as shown in Fig. 1.

   a. If the oxygen sensor has a metal stone shield around the sensor body continue with Step B.

   b. If the sensor does not have a stone shield, a new sensor has already been installed and no further service is required.

WARNING: Exhaust manifold becomes very hot during engine operation. Allow engine to cool before removing oxygen sensor.

1. Disconnect the oxygen sensor electrical connector.

2. Remove oxygen sensor using a crowfoot socket.

3. Clean exhaust manifold threads.

4. Install provided oxygen sensor (P/N C3905610). Tighten to 30 N.m (22 ft-lb).

5. Connect oxygen sensor connector.

6. Lower vehicle.

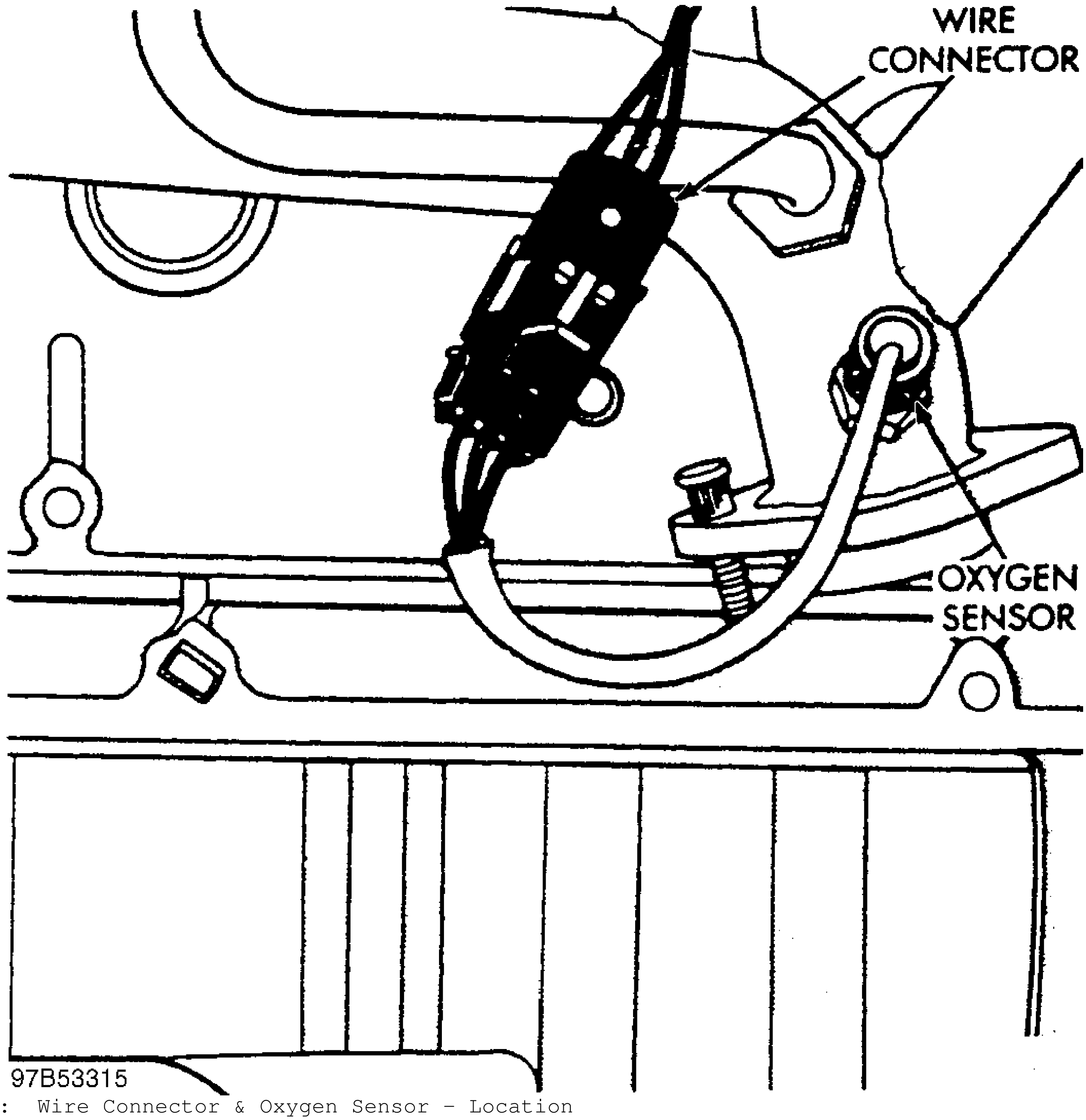


Fig. 1: Wire Connector & Oxygen Sensor - Location

CUSTOMER NOTIFICATION LETTER

EMISSIONS RECALL - OXYGEN SENSOR REPLACEMENT

Dear Chrysler Vehicle Owner:

Chrysler Corporation and the Environmental Protection Agency has determined that the oxygen sensor on certain Cherokee, Wagoneer and Comanche models may be susceptible to failure. Failure of the oxygen sensor may cause your vehicle to be in violation of Federal Emissions Standards. For this reason, we are asking you to return your vehicle, identified by the Vehicle Identification Number on the enclosed form, to your dealer for a special service repair. This service will be provided free of charge.

The needed instructions have been sent to all involved dealers. The service will not hurt your engine performance or fuel economy. To obtain this service:

* Contact your Jeep/Eagle dealer as soon as possible to make an appointment for the free service.

* Take the enclosed Owner Notification Form with you at the time of your appointment and give it to your dealer. The form identifies the vehicle and recall for which service is required.

* The dealer will inspect and replace the oxygen sensor if necessary. The service will take about one-half hour, but additional time may be required depending on how service appointments are scheduled and processed.

In order to ensure your full protection under the emission warranty made applicable to your vehicle under Federal law, and your right to participate in future recalls, it is recommended that you have your vehicle serviced as soon as possible. Failure to do so could legally be determined to be a lack of proper maintenance of your vehicle. Further, without this repair your vehicle may fail a state or local emission inspection test.

If you have any problem obtaining the service, please contact the Chrysler Zone Service Office in your area. (It is listed under "Service Assistance" in your Owner's Manual.} A Zone representative will arrange for prompt servicing of your vehicle. If you are still unable to obtain the repair as described in this letter within a reasonable time, you may also contact the Manufacturers Operations Division of the Environmental Protection Agency (6405d), 401 M Street S. W., Washington, D. C. 20460.

We regret any inconvenience this action may cause, but trust you understand our interest in clean air and in your continuing satisfaction with our product. Thank you for your prompt attention to this important matter.

Customer Services Field Operations
Chrysler Corporation

COMPLETION REPORTING & REIMBURSEMENT

Claims for vehicles which have been serviced must be submitted on the DIAL System. Claims submitted will be used by Chrysler to record recall service completions and provide dealer payments.

Use ONE of the following labor operation numbers and time allowances:

Labor Operation No.: 25561181 - Inspect Oxygen Sensor
Time Allowance: 0.2 hr.

Labor Operation No.: 25561182 - Replace Oxygen Sensor
Time Allowance: 0.3 hr.

Add the cost of the recall parts package plus applicable dealer allowance to your claim.

Parts Return

Initially, a small number of oxygen sensors are required to be returned to the Warranty Material Return Center. When an adequate number of returned parts have been accumulated, Parts Return Documents will no longer be generated and parts are to be discarded.

NOTE: See Warranty Policy and Procedure Manual, Chapter 6, Subsection H for complete recall claim processing and material return instructions.

Vehicle Not Available

If a vehicle is not available for service for a known reason, let us know by filling out the pre-addressed Vehicle Disposition Form portion of the Owner Notification Form or describe the reason on a postcard and mail to:

Chrysler Corporation 429-10-04
P.O. Box 1919
Detroit, Michigan 48231-1919

Following the above procedures will expedite the processing of your claim.

If you have any questions or need assistance in completing this action, please contact your Zone Service Office.

RIDING HEIGHT ADJUSTMENT

1988 Jeep Cherokee

1988 RIDING HEIGHT SPECIFICATIONS
Chrysler Motors & Jeep

All Models

RIDING HEIGHT SPECS

There are no RIDE HEIGHT specifications available for all Chrysler and Jeep models.

SCHEDULED SERVICES - GASOLINE

1988 Jeep Cherokee

1984-88 MAINTENANCE
AMC/Jeep Maintenance & Service Intervals - Gasoline

Jeep; Cherokee, Wagoneer

* PLEASE READ THIS FIRST *

NOTE: All SERVICE SCHEDULES are listed for normal service vehicles. If vehicle is operated under severe service conditions, see SEVERE SERVICE REQUIREMENTS (PERFORM W/SERVICE SCHEDULES) for items requiring additional maintenance.

NOTE: This article contains scheduled maintenance service information. Fluid types and capacities listed with each service in this article are only those necessary to perform that scheduled service. For specifications pertaining to fluid capacities for the entire vehicle, fuse and circuit breaker identification, wheel and tire size, battery type, warranty information, or model identification refer to the MAINTENANCE INFORMATION article in this section.

CAUTIONS & WARNINGS

AIR CONDITIONING MAINTENANCE

WARNING: NEVER add A/C refrigerant to correct a non-cooling problem unless pressure gauges are connected to the system by a certified technician. Lack of cooling may be caused by a restriction, therefore adding refrigerant can cause a dangerous pressure rise.

ANTI-LOCK BRAKE SYSTEM (If Equipped)

The anti-lock brake system contains electronic equipment that can be susceptible to interference caused by improperly installed or high output radio transmitting equipment. Since this interference could cause the possible loss of the anti-lock braking capability, such equipment should be installed by qualified professionals.

On models equipped with anti-lock brake systems, ALWAYS observe the following cautions:

* DO NOT attempt to bleed hydraulic system without first referring to the appropriate ANTI-LOCK BRAKE SYSTEM article in the BRAKES Section.
* DO NOT mix tire sizes. As long as tires remain close to the original diameter, increasing the width is acceptable. Rolling diameter must be identical for all 4 tires. Some manufacturers recommend tires of the same brand, style and type. Failure to follow this precaution may cause inaccurate wheel speed readings.
* Use ONLY recommended brake fluids. DO NOT use silicone brake fluids in an ABS-equipped vehicle.

BATTERY WARNING

WARNING: When battery is disconnected, vehicles equipped with

computers may lose memory data. When battery power is restored, driveability problems may exist on some vehicles. These vehicles may require a relearn procedure. See COMPUTER RELEARN PROCEDURES article in GENERAL INFORMATION section.

REPLACING BLOWN FUSES

Before replacing a blown fuse, remove ignition key, turn off all lights and accessories to avoid damaging the electrical system. Be sure to use fuse with the correct indicated amperage rating. The use of an incorrect amperage rating fuse may result in a dangerous electrical system overload.

BRAKE PAD WEAR INDICATOR

Indicator will cause a squealing or scraping noise, warning that brake pads need replacement.

BRAKE WARNING LIGHT

CAUTION: If BRAKE warning light is on with parking brake disengaged and engine running, there may be a problem in the hydraulic brake system. Braking effort, brake pedal travel and stopping distances may increase.

CATALYTIC CONVERTER

To prevent catalytic converter overheating, DO NOT allow engine to idle for more than 20 minutes.

COMMAND-TRAC (4WD)

CAUTION: NEVER operate a Command-Trac vehicle in 4WD on dry, hard-surfaced roads for a sustained period. Use 4L only when needed for added pulling power. Operating vehicle in 4WD mode on such roads will cause stress and possible damage to components, as well as make shifting difficult. To reduce shifting effort, drive vehicle in Reverse for a few feet, or drive off hard-surfaced road momentarily to allow tire slippage.

FRONT AND REAR DIFFERENTIALS (4WD)

CAUTION: DO NOT use water, steam, kerosene or gasoline for flushing a differential. ONLY use a flushing oil.

TRAC-LOK DIFFERENTIALS (4WD)

CAUTION: DO NOT flush a rear axle Trac-Lok differential. Trac-Lok differentials may be cleaned only by disassembling the unit and wiping the components with clean, lint-free cloth.

CAUTION: NEVER attempt to engage Low range when vehicle is moving faster than 2-3 MPH, as transfer case damage may result.

GASOLINE CONTAINING ALCOHOL

CAUTION: Exclusive use of gasohol is not recommended. Vehicle test results have shown that significant fuel system corrosion can result when gasohol is used exclusively.

HALOGEN BULBS

Halogen bulbs contain pressurized gas which may explode if overheated. DO NOT touch glass portion of bulb with bare hands. Eye protection should be worn when handling or working around halogen bulbs.

OIL FILTER

CAUTION: The engine oil filter mount has metric threads. Use of a filter with improper threads can result in oil leakage and possible engine damage. Look for M20 x 1.5 symbol on the filter.

RADIATOR CAP

CAUTION: Always disconnect the fan motor when working near the radiator fan. The fan is temperature controlled and could start at any time even when the ignition key is in the OFF position. DO NOT loosen or remove radiator cap when cooling system is hot.

RADIATOR FAN

Keep hands away from radiator fan. Fan is controlled by a thermostatic switch which may come on or run for up to 15 minutes even after engine is turned off.

WHEEL & TIRE WARNINGS

CAUTION: Replacing original tires with different size tires may result in false speedometer and odometer indications. Check with dealer before using different size tires on vehicle.

CAUTION: Ensure all 4 wheels on vehicle have same tire size, type and circumference in order to provide proper vehicle handling. DO NOT mix radial-ply with bias-ply or bias-belted tires. On 4WD vehicles, if tire size, type and circumference on all 4 wheels are not the same, gear shifting will be adversely affected and can damage transfer case.

CAUTION: Temporary-use spare tires are for emergency use only. DO NOT drive vehicle faster than 50 MPH or more than 100 miles when using spare tire. DO NOT operate vehicle in 4WD mode when using spare tire, as damage to transfer case can result. Temporary-use spare tires have a total tread life of 3,000 miles.

SERVICE POINT LOCATIONS

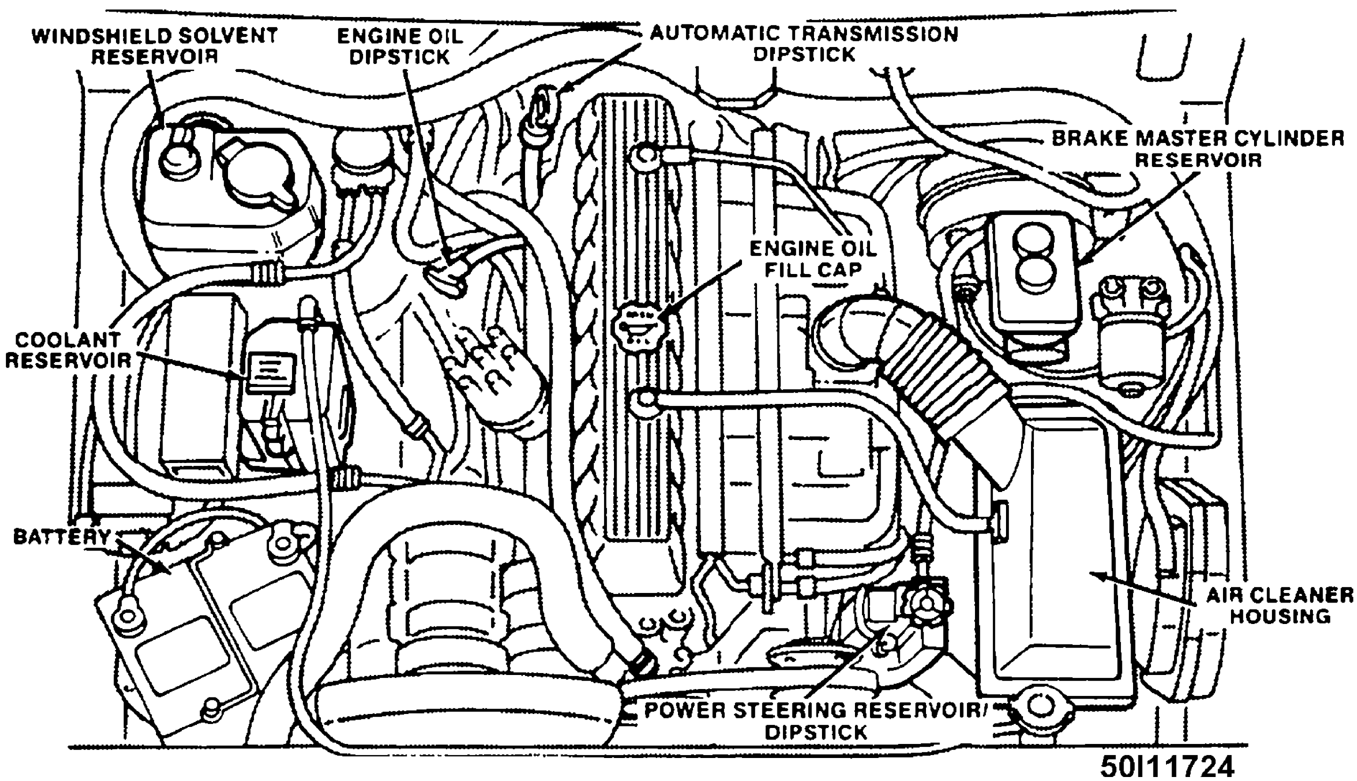


Fig. 1: Service Point Locations (Typical)
Courtesy of American Motors Corp.

ADDITIONAL SERVICE INFORMATION

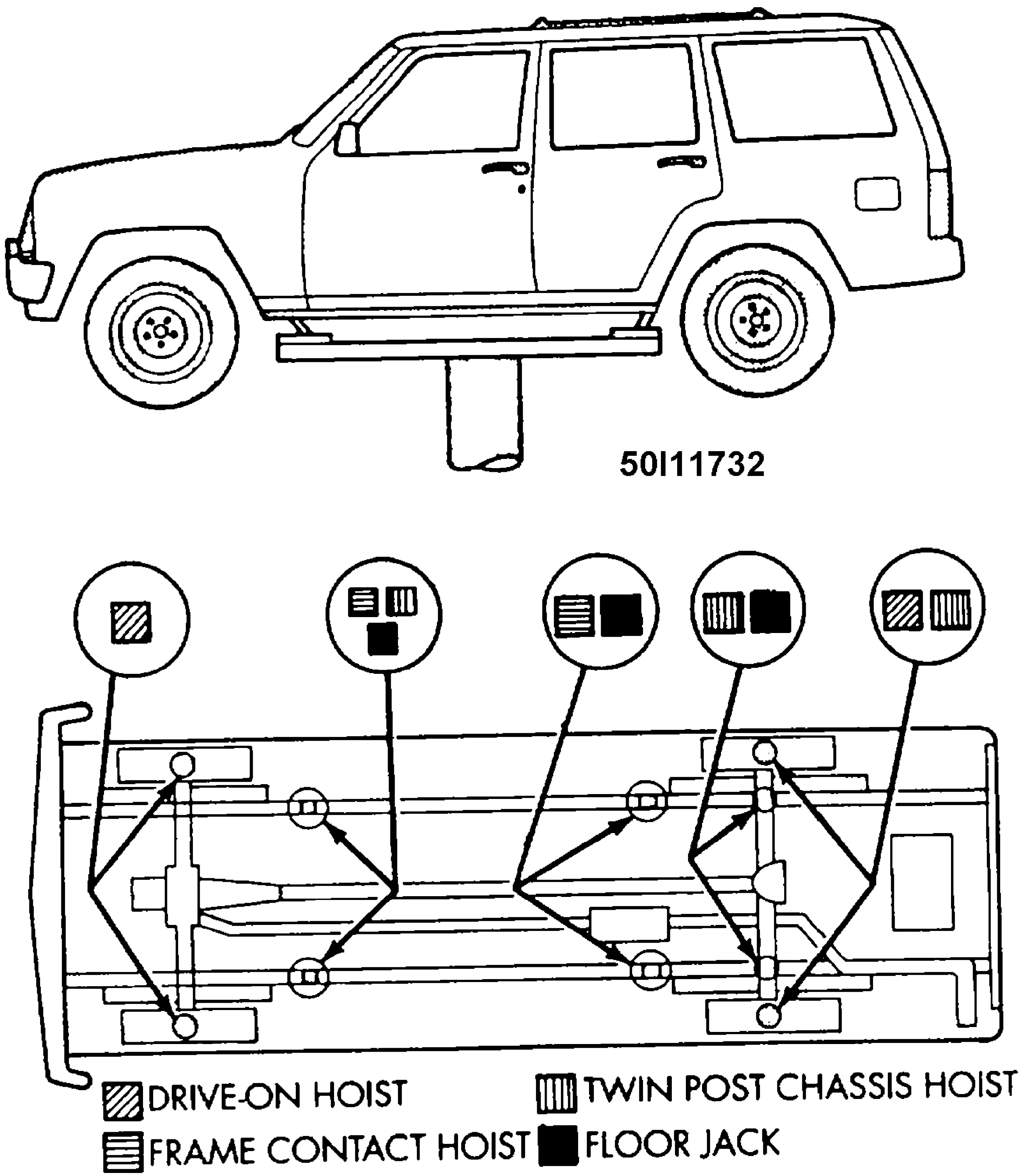


Fig. 2: Hoist Lift Point Locations
Courtesy of American Motors Corp.

NOTE: For more information regarding jacking and hoisting refer to the JACKING & HOISTING article in the

WHEEL ALIGNMENT section.

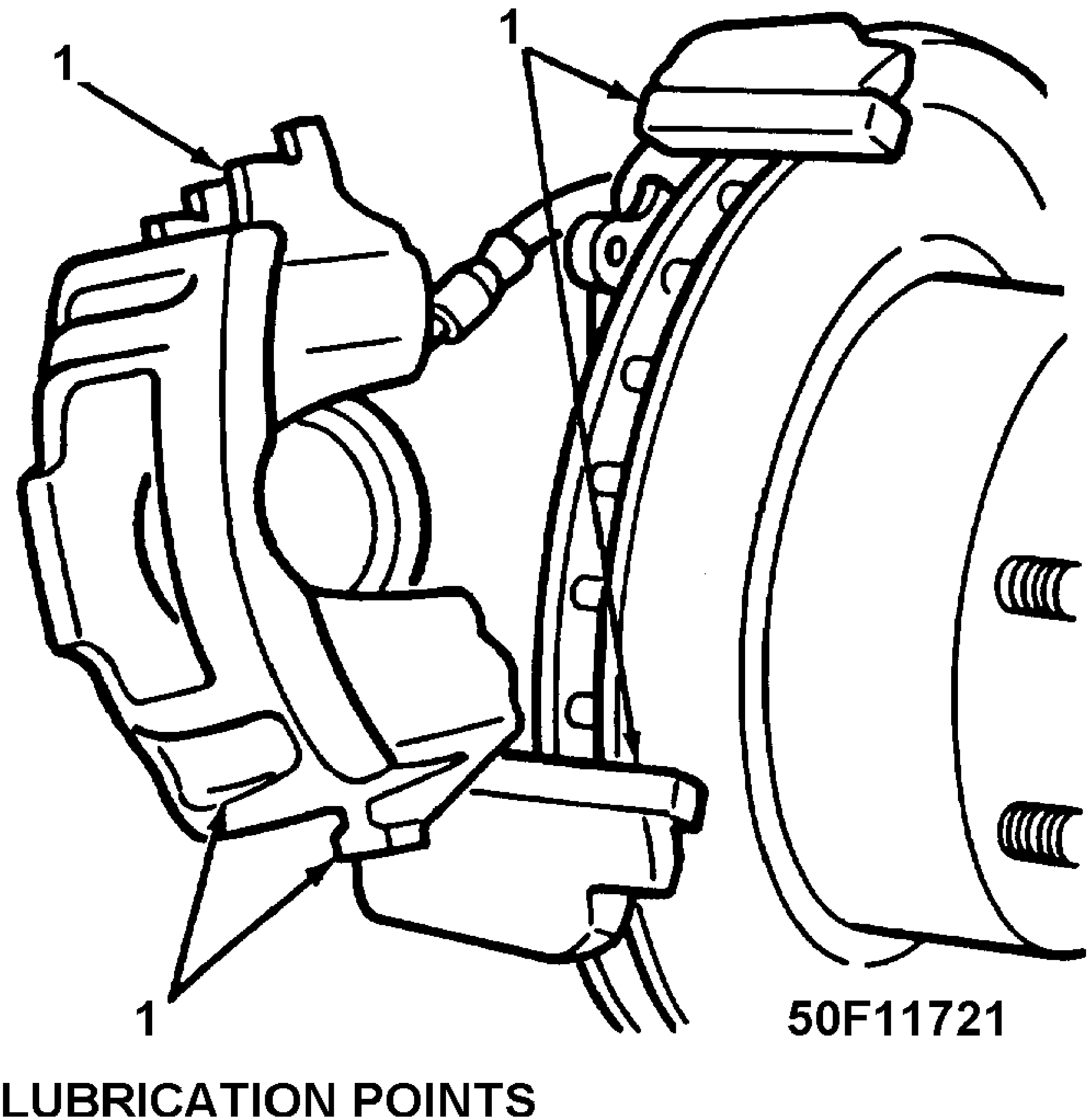


Fig. 3: Brake Caliper Lubrication Points
Courtesy of American Motors Corp.

NOTE: For more information regarding brake maintenance refer to the BRAKE SYSTEM article.

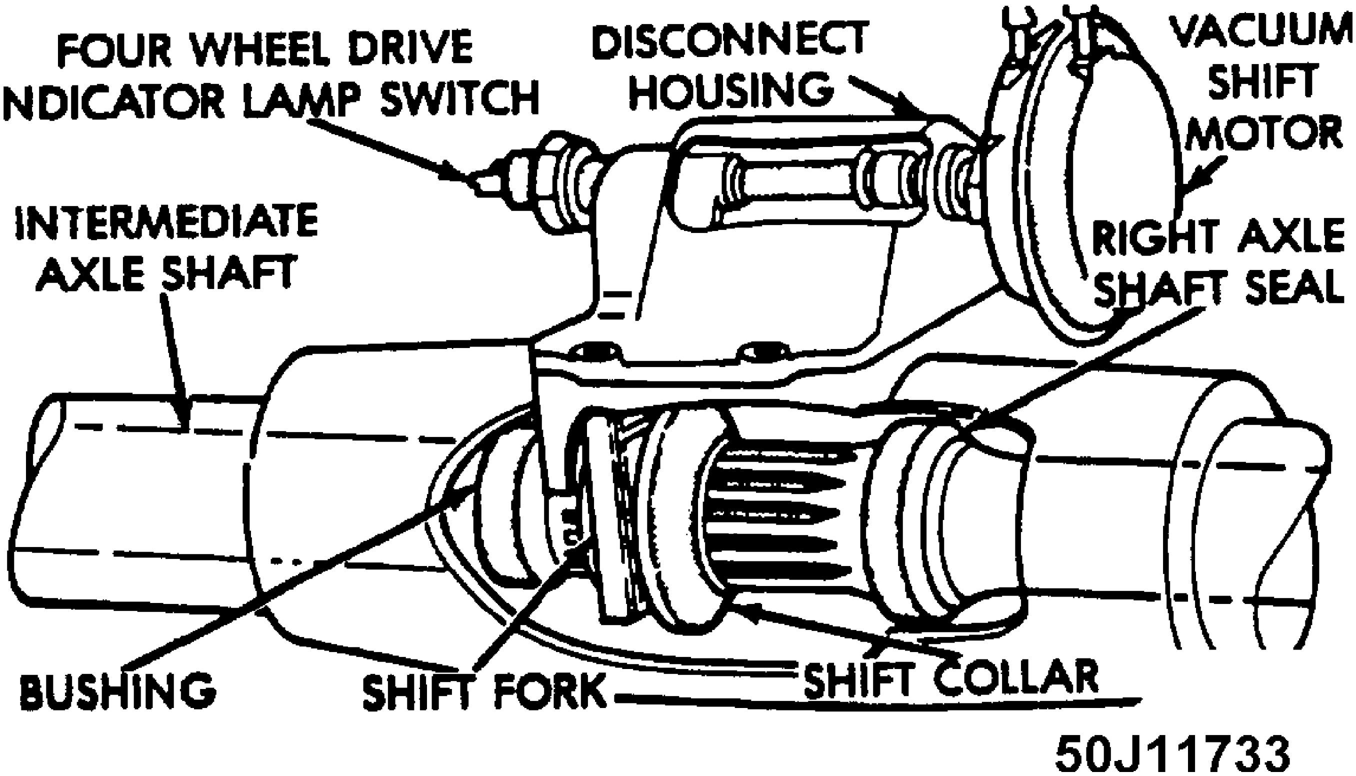
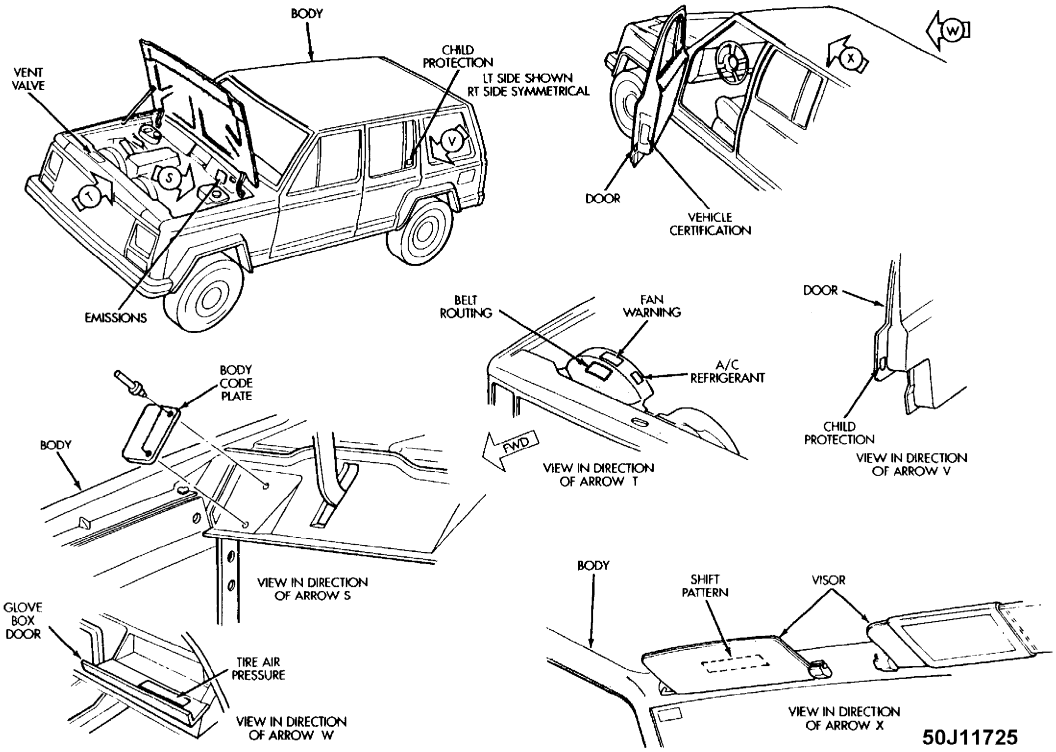


Fig. 4: Front Disconnect Housing Lubrication Point
Courtesy of American Motors Corp.

IDENTIFICATION LABEL LOCATIONS



VEHICLE, LABELS AND PLATES

Fig. 5: Identification Label Locations
Courtesy of American Motors Corp.

SPARK PLUG REPLACEMENT INTERVALS

Spark plug replacement intervals, if given, are for Original Equipment Manufacturer (OEM) installed or specified plugs. If vehicle is equipped with platinum type or other non-OEM type spark plugs, follow replacement interval specified by spark plug manufacturer.

OXYGEN SENSOR

If vehicle is equipped with an oxygen sensor, replace at 82, 500 miles or when the emissions maintenance reminder light remains on continuously with the key in the ON position, whichever occurs first.

SEVERE & NORMAL SERVICE DEFINITIONS

CAUTION: Use the Severe Service schedule if the vehicle to be serviced is operated under ANY (one or more) of these conditions:

Service is recommended at mileage intervals based on vehicle operation. Normal Service and Severe Service are based on the following primary operating conditions:

Severe Service

* Short Trips (About 15 Miles)
* Desert Or Cold Climate Operation
* Towing Or Heavily Loaded
* Severe Dust Conditions
* Hot Weather, Stop-And-Go Driving

* Sustained High Speed Driving
* Extensive Idling Conditions (Taxi Or Delivery-Type Service)
* Driving Off-Road Or In Salty Or Sandy Areas
* Driving In Water

Normal Service

* Driven More Than 10 Miles Daily
* No Severe Service Operating Conditions

SEVERE SERVICE REQUIREMENTS (PERFORM W/SERVICE SCHEDULES)

NOTE: The following services are to be performed on vehicles subjected to severe service. See SEVERE & NORMAL SERVICE DEFINITIONS. This service is to be performed in addition to the normal services listed in the NORMAL MAINTENANCE SERVICE SCHEDULES.

SEVERE SERVICE CONDITIONS/ACTIONS TABLE

Condition	Action	Item	Perform Every (1)
Short Trips (About 15 Miles)	Replace	Engine Oil	3,000 Miles or 3 Months
	Replace	Engine Oil Filter	6,000 Miles or 6 Months
	Service	Lube Prop Shaft If Equipped With Fittings	3,000 Miles
	Replace	A/T Fluid	12,000 Miles
	Replace	Front And/Or Rear Axle Oil	12,000 Miles
	Replace	M/T Fluid Oil	18,000 Miles
Desert Or Cold Climate Operations	Replace	Engine Oil	3,000 Miles or 3 Months
	Replace	Engine Oil Filter	6,000 Miles or 6 Months
	Service	Lube Prop Shaft If Equipped With Fittings	3,000 Miles
	Replace	A/T Fluid	12,000 Miles
	Replace	Front And/Or Rear Axle Oil	12,000 Miles
	Replace	M/T Fluid Oil	18,000 Miles
Towing Or Heavily Loaded	Replace	Engine Oil	3,000 Miles or 3 Months
	Replace	Engine Oil Filter	6,000 Miles or 6 Months
	Service	Lube Prop	3,000 Miles

		Shaft If Equipped With Fittings	
	Replace	A/T Fluid	12,000 Miles
	Replace	Front And/Or Rear Axle Oil	12,000 Miles
	Replace	M/T Fluid Oil	18,000 Miles
Severe Dust Conditions	Replace	Engine Oil	3,000 Miles or 3 Months
	Replace	Engine Oil Filter	6,000 Miles or 6 Months
	Service	Lube Prop Shaft If Equipped With Fittings	3,000 Miles
	Replace	A/T Fluid	12,000 Miles
	Replace	Front And/Or Rear Axle Oil	12,000 Miles
	Replace	M/T Fluid Oil	18,000 Miles
Hot Weather, Stop-And-Go Driving	Replace	Engine Oil	3,000 Miles or 3 Months
	Replace	Engine Oil Filter	6,000 Miles or 6 Months
	Service	Lube Prop Shaft If Equipped With Fittings	3,000 Miles
	Replace	A/T Fluid	12,000 Miles
	Replace	Front And/Or Rear Axle Oil	12,000 Miles
	Replace	M/T Fluid Oil	18,000 Miles
Sustained High Speed Driving	Replace	Engine Oil	3,000 Miles or 3 Months
	Replace	Engine Oil Filter	6,000 Miles or 6 Months
	Service	Lube Prop Shaft If Equipped With Fittings	3,000 Miles
	Replace	A/T Fluid	12,000 Miles
	Replace	Front And/Or Rear Axle Oil	12,000 Miles
	Replace	M/T Fluid Oil	18,000 Miles
Extensive Idling	Replace	Engine Oil	3,000 Miles or 3 Months

Conditions (Taxi Or Delivery Type Service)	Replace	Engine Oil Filter	6,000 Miles or 6 Months
	Service	Lube Prop Shaft If Equipped With Fittings	3,000 Miles
	Replace	A/T Fluid	12,000 Miles
	Replace	Front And/Or Rear Axle Oil	12,000 Miles
	Replace	M/T Fluid Oil	18,000 Miles
Driving Off-Road Or In Salty Or Sandy Areas	Replace	Engine Oil	3,000 Miles or 3 Months
	Replace	Engine Oil Filter	6,000 Miles or 6 Months
	Replace	4WD: Engine Oil	50 Hours
	Service	Lube Prop Shaft If Equipped With Fittings	3,000 Miles
	Replace	A/T Fluid	12,000 Miles
	Replace	Front And/Or Rear Axle Oil	12,000 Miles
	Replace	M/T Fluid Oil	18,000 Miles
Driving In Water	Replace	Engine Oil	3,000 Miles or 3 Months
	Replace	Engine Oil Filter	6,000 Miles or 6 Months
	Service	Lube Prop Shaft If Equipped With Fittings	3,000 Miles
	Replace	A/T Fluid	12,000 Miles
	Replace	Front And/Or Rear Axle Oil	12,000 Miles
	Replace	M/T Fluid Oil	18,000 Miles
	Service	Lube Prop Shaft Slip Splines	Daily

(1) - Perform these services at the mileage, hours of operation, or number of months (since last time), whichever comes first.

NORMAL MAINTENANCE SERVICE SCHEDULES

CAUTION: The following service schedules refer to vehicles driven under normal operating conditions. For vehicles driven under severe conditions, additional services may be necessary. See SEVERE SERVICE REQUIREMENTS (PERFORM W/SERVICE SCHEDULES) above in this article for additional service requirements.

5,000 MILE (8,000 KM) SERVICE

5,000 MILE (8,000 KM) SERVICE

Service Or Inspect	
	Check Fluid Levels
	Inspect Coolant Hoses and Clamps
	Curb & Fast Idle Speed

7,500 MILE (12,000 KM) SERVICE

7,500 MILE (12,000 KM) SERVICE

Service Or Inspect	
	Check Fluid Levels
	Inspect Coolant Hoses and Clamps
	Inspect Brake System
	Inspect Exhaust System
	Inspect Underside of Vehicle (Bolts & Threaded Fasteners)
	Check/Lube Manual Steering Gear
	Check Drive Shaft Seals
	Lubricate Ball Joints, Steering Linkage & Suspension
	Lube Drive Shaft U-Joints and Slip Splines
	Lube Front Axle Drive Joint and Pivot Bearings (4WD)
	Rotate Tires and Adjust Air Pressure (Including Spare)
Replace	
	Engine Oil
	Oil Filter
	Rear Axle Fluid (Limited Slip)
Lubrication Specifications	
Application	Specification

Automatic Transmission	Dexron-IIE ATF
Brake Master Cylinder	DOT 3 (SAE J-1703F) Brake Fluid
Engine Coolant	Alugard 340-2 & Water (50/50 Mixture)
Engine Oil (1)	
Gasoline Engine	
Temperature Range	
Above 30° F (-1°C)	SAE 20W-40 Or 20W-50 API SH/CD
Above 0° F (-18°C)	SAE 10W-30 Or 10W-40 API SH/CD
Less Than 60° F (16°C)	SAE 5W-30 API SH/CD
Drive Axles	SAE 75W-90 API GL-5
Drive Axles (Trac-Lok) (2)	SAE 80W-140 API GL-5
Drive Axles (Trailer Towing)	SAE 80W-140 API GL-5
Hydraulic Clutch	DOT 3 (SAE J-1703F) Brake Fluid
Manual Transmission	SAE 75W-90 API GL-5
Parking Brake Cable Guides	NLGI Grade 2, GC-LB
Door & Hood Hinges	Light Engine Oil
Manual Steering Box	Multi-Purpose NLGI Grade 2EP
Power Steering Pump	Power Steering Fluid
Transfer Case	Dexron-IIE ATF
Brake Caliper Bushings	GE 661 or DOW 111 Silicone Grease
Caliper Slide Pins	GE 661 or DOW 111 Silicone Grease
Wheel Bearings	Multi-Purpose NLGI Grade GC-LB
Drive Shaft U-Joints	Multi-Purpose NLGI Grade 2EP
Steering Linkage (4)(5)	NLGI Grade 2, GC-LB
Ball Joints (4)(6)	NLGI Grade 2, GC-LB
Weatherstrip	Silicone Spray Lubricant
Wheel Lug Nut Torque	95 ft. lbs. (129 N.m)

(1) - SAE 10W-30 SH/CD is preferred.
(2) - Add 4 ozs. (118 ml) of Limited-Slip differential lubricant additive when changing fluid.
(3) - For vehicles operating under heavy-duty towing conditions, use SAE 75W-140 Synthetic lube.
NOTE: Before using SAE 75W-140 Synthetic the old fluid must be DRAINED and FLUSHED with clean mineral based axle lubricant. Then refill with new synthetic lube.
(4) - Use low pressure grease gun to prevent seal damage.
(5) - Fill until lubricant squeezes out from the base of seals.
(6) - Fill ball joint until seal starts to swell.

Fluid Capacities

Application	(1) Quantity
Automatic Transmission	
1984-86 (904 HD)	
Fluid Change	4.0 Qts. (3.8L)
Overhaul (Dry Fill)	8.0 Qts. (7.6L)
1987-88	
Fluid Change	4.0 Qts. (3.8L)
Overhaul (Dry Fill)	8.5 Qts. (8.0L)
Cooling System (2)	
4-Cylinder	10.0 Qts. (9.5L)
6-Cylinder	12.0 Qts. (11.4L)
Engine Oil	
4-Cylinder	4.0 Qts. (3.8L)
6-Cylinder	6.0 Qts. (5.7L)
Fuel Tank	
Standard	13.5 Gals. (51.1L)
Optional	20 Gals. (75.7L)
Manual Transmission (3)	
AX4 (AISIN)	7.4 Pts. (3.5L)
T4 (Borg-Warner)	3.9 Pts. (1.8L)

AX5 (AISIN)	7.0 Pts. (3.3L)
T5 (Borg-Warner)	4.5 Pts. (2.1L)
Transfer Case	
1985-86	
Selec-Trac (229 Full-Time)	6.0 Pts. (2.8L)
Command-Trac (Part-Time 207)	4.5 Pts. (2.1L)
1987	
Selec-Trac	2.5 Pts. (1.2L)
Command-Trac	2.2 Pts. (1.0L)
1988	
Selec-Trac	3.0 Pts. (1.4L)
Command-Trac	2.2 Pts. (1.0L)
Drive Axles (3)	
Front	2.5 Pts. (1.2L)
Front (Disconnect Housing)	5.0 Ozs. (0.15L)
Rear	2.5 Pts. (1.2L)
Rear (Trac-Lok) (4)	2.5 Pts. (1.2L)

(1) - Capacities are recommended or calculated levels. Always use dipstick (if available) to measure level.
(2) - Includes 2.3 qts. for coolant recovery bottle.
(3) - Fill to bottom of filler plug hole.
(4) - Add 4 ozs. (118 ml) of Limited-Slip differential lubricant additive first, then add new fluid.

15,000 MILE (24,000 KM) SERVICE

15,000 MILE (24,000 KM) SERVICE

	Service Or Inspect
	Verify Last Major Service Was Performed
	Check Fluid Levels
	Check Cooling System Hoses and Clamps
	Check Coolant Strength
	Check Exhaust System & Heat Shielding
	Clean Battery and Battery Terminals
	Accessory Drive Belts
	Inspect Brake System
	Inspect C/V Joint boots (4WD)
	Inspect Underside of Vehicle (Bolts & Threaded Fasteners)
	Check/Lube Manual Steering Gear
	Check Drive Shaft Seals
	Lubricate Ball Joints, Steering Linkage & Suspension
	Lube Drive Shaft U-Joints and Slip Splines
	Lube Front Axle Drive Joint and Pivot Bearings (4WD)

	Inspect Front Wheel Bearings (4WD)
	Check Operation of Horn, Wipers/Washers & All Exterior Lights
	Inspect Condition of Wiper Blades
	Check Headlight Alignment
	Check Seat Belt Webbing and Release Mechanisms
	Check Parking Brake Operation
	Check Shift/Clutch Interlock Operation
	Lubricate Weatherstripping with Silicone
	Lubricate Door Hinges
	Lubricate Door Locks
	Check Body Drain Holes
	Rotate Tires and Adjust Air Pressure
Replace	
	Engine Oil
	Oil Filter
	Automatic Transmission Fluid, Filter and Adjust Bands
Lubrication Specifications	

Application	Specification
Automatic Transmission	Dexron-IIE ATF
Brake Master Cylinder	DOT 3 (SAE J-1703F) Brake Fluid
Engine Coolant	Alugard 340-2 & Water (50/50 Mixture)
Engine Oil (1)	
Gasoline Engine	
Temperature Range	
Above 30° F (-1°C)	SAE 20W-40 Or 20W-50 API SH/CD
Above 0° F (-18°C)	SAE 10W-30 Or 10W-40 API SH/CD
Less Than 60° F (16°C)	SAE 5W-30 API SH/CD
Drive Axles	SAE 75W-90 API GL-5
Drive Axles (Trac-Lok) (2)	SAE 80W-140 API GL-5
Drive Axles (Trailer Towing)	SAE 80W-140 API GL-5
Hydraulic Clutch	DOT 3 (SAE J-1703F) Brake Fluid
Manual Transmission	SAE 75W-90 API GL-5
Parking Brake Cable Guides	NLGI Grade 2, GC-LB
Door & Hood Hinges	Light Engine Oil
Manual Steering Box	Multi-Purpose NLGI Grade 2EP
Power Steering Pump	Power Steering Fluid
Transfer Case	Dexron-IIE ATF
Brake Caliper Bushings	GE 661 or DOW 111 Silicone Grease
Caliper Slide Pins	GE 661 or DOW 111 Silicone Grease
Wheel Bearings	Multi-Purpose NLGI Grade GC-LB
Drive Shaft U-Joints	Multi-Purpose NLGI Grade 2EP
Steering Linkage (4)(5)	NLGI Grade 2, GC-LB
Ball Joints (4)(6)	NLGI Grade 2, GC-LB
Weatherstrip	Silicone Spray Lubricant
Wheel Lug Nut Torque	95 ft. lbs. (129 N.m)

(1) - SAE 10W-30 SH/CD is preferred.
(2) - Add 4 ozs. (118 ml) of Limited-Slip differential lubricant additive when changing fluid.
(3) - For vehicles operating under heavy-duty towing conditions, use SAE 75W-140 Synthetic lube.
NOTE: Before using SAE 75W-140 Synthetic the old fluid must be DRAINED and FLUSHED with clean mineral based axle lubricant. Then refill with new synthetic lube.
(4) - Use low pressure grease gun to prevent seal damage.
(5) - Fill until lubricant squeezes out from the base of seals.
(6) - Fill ball joint until seal starts to swell.

Fluid Capacities

Application	(1) Quantity
Automatic Transmission	
1984-86 (904 HD)	
Fluid Change	4.0 Qts. (3.8L)
Overhaul (Dry Fill)	8.0 Qts. (7.6L)
1987-88	
Fluid Change	4.0 Qts. (3.8L)
Overhaul (Dry Fill)	8.5 Qts. (8.0L)
Cooling System (2)	
4-Cylinder	10.0 Qts. (9.5L)
6-Cylinder	12.0 Qts. (11.4L)
Engine Oil	
4-Cylinder	4.0 Qts. (3.8L)
6-Cylinder	6.0 Qts. (5.7L)
Fuel Tank	
Standard	13.5 Gals. (51.1L)
Optional	20 Gals. (75.7L)
Manual Transmission (3)	
AX4 (AISIN)	7.4 Pts. (3.5L)
T4 (Borg-Warner)	3.9 Pts. (1.8L)
AX5 (AISIN)	7.0 Pts. (3.3L)
T5 (Borg-Warner)	4.5 Pts. (2.1L)
Transfer Case	
1985-86	
Selec-Trac (229 Full-Time)	6.0 Pts. (2.8L)
Command-Trac (Part-Time 207)	4.5 Pts. (2.1L)
1987	
Selec-Trac	2.5 Pts. (1.2L)
Command-Trac	2.2 Pts. (1.0L)
1988	
Selec-Trac	3.0 Pts. (1.4L)
Command-Trac	2.2 Pts. (1.0L)
Drive Axles (3)	
Front	2.5 Pts. (1.2L)
Front (Disconnect Housing)	5.0 Ozs. (0.15L)
Rear	2.5 Pts. (1.2L)
Rear (Trac-Lok) (4)	2.5 Pts. (1.2L)

(1) - Capacities are recommended or calculated levels. Always use dipstick (if available) to measure level.
(2) - Includes 2.3 qts. for coolant recovery bottle.
(3) - Fill to bottom of filler plug hole.
(4) - Add 4 ozs. (118 ml) of Limited-Slip differential lubricant additive first, then add new fluid.

22,500 MILE (36,000 KM) SERVICE

22,500 MILE (36,000 KM) SERVICE

	Service Or Inspect
	Verify Last Major Service Was Performed
	Check Fluid Levels
	Check Fuel Lines, Connections and Valves (CNG Models)
	Check Cooling System Hoses and Clamps
	Check Exhaust System & Heat Shielding
	Lube Parking Brake Ratio Lever Pivot
	Lube Manual Gearshift Control (4WD Transfer Case)
	Inspect C/V Joint boots (4WD)
	Inspect Underside of Vehicle (Bolts & Threaded Fasteners)
	Check/Lube Manual Steering Gear
	Check Drive Shaft Seals
	Lubricate Ball Joints, Steering Linkage & Suspension
	Lube Drive Shaft U-Joints and Slip Splines
	Lube Front Axle Drive Joint and Pivot Bearings (4WD)
	Inspect/Repack Front Wheel Bearings (2WD Models)
	Inspect Front Brake Pads & Rotors
	Lubricate Caliper Slide Rails
	Inspect Rear Brake Linings & Drums
	Inspect Brake System Hoses & Lines
	Inspect Shocks for Leakage
	Inspect Tire Wear Pattern
	Rotate Tires and Adjust Air Pressure (Including Spare)
	Replace
	Engine Oil
	Oil Filter
	Lubrication Specifications

Application	Specification
Automatic Transmission	Dexron-IIE ATF
Brake Master Cylinder	DOT 3 (SAE J-1703F) Brake Fluid

Engine Coolant	Alugard 340-2 & Water (50/50 Mixture)
Engine Oil (1)	
Gasoline Engine	
Temperature Range	
Above 30° F (-1°C)	SAE 20W-40 Or 20W-50 API SH/CD
Above 0° F (-18°C)	SAE 10W-30 Or 10W-40 API SH/CD
Less Than 60° F (16°C)	SAE 5W-30 API SH/CD
Drive Axles	SAE 75W-90 API GL-5
Drive Axles (Trac-Lok) (2)	SAE 80W-140 API GL-5
Drive Axles (Trailer Towing)	SAE 80W-140 API GL-5
Hydraulic Clutch	DOT 3 (SAE J-1703F) Brake Fluid
Manual Transmission	SAE 75W-90 API GL-5
Parking Brake Cable Guides	NLGI Grade 2, GC-LB
Door & Hood Hinges	Light Engine Oil
Manual Steering Box	Multi-Purpose NLGI Grade 2EP
Power Steering Pump	Power Steering Fluid
Transfer Case	Dexron-IIE ATF
Brake Caliper Bushings	GE 661 or DOW 111 Silicone Grease
Caliper Slide Pins	GE 661 or DOW 111 Silicone Grease
Wheel Bearings	Multi-Purpose NLGI Grade GC-LB
Drive Shaft U-Joints	Multi-Purpose NLGI Grade 2EP
Steering Linkage (4)(5)	NLGI Grade 2, GC-LB
Ball Joints (4)(6)	NLGI Grade 2, GC-LB
Weatherstrip	Silicone Spray Lubricant
Wheel Lug Nut Torque	95 ft. lbs. (129 N.m)

(1) - SAE 10W-30 SH/CD is preferred.
(2) - Add 4 ozs. (118 ml) of Limited-Slip differential lubricant additive when changing fluid.
(3) - For vehicles operating under heavy-duty towing conditions, use SAE 75W-140 Synthetic lube.
NOTE: Before using SAE 75W-140 Synthetic the old fluid must be DRAINED and FLUSHED with clean mineral based axle lubricant. Then refill with new synthetic lube.
(4) - Use low pressure grease gun to prevent seal damage.
(5) - Fill until lubricant squeezes out from the base of seals.
(6) - Fill ball joint until seal starts to swell.

Fluid Capacities

Application	(1) Quantity
Automatic Transmission	
1984-86 (904 HD)	
Fluid Change	4.0 Qts. (3.8L)
Overhaul (Dry Fill)	8.0 Qts. (7.6L)
1987-88	
Fluid Change	4.0 Qts. (3.8L)
Overhaul (Dry Fill)	8.5 Qts. (8.0L)
Cooling System (2)	
4-Cylinder	10.0 Qts. (9.5L)
6-Cylinder	12.0 Qts. (11.4L)
Engine Oil	
4-Cylinder	4.0 Qts. (3.8L)
6-Cylinder	6.0 Qts. (5.7L)
Fuel Tank	
Standard	13.5 Gals. (51.1L)
Optional	20 Gals. (75.7L)
Manual Transmission (3)	
AX4 (AISIN)	7.4 Pts. (3.5L)
T4 (Borg-Warner)	3.9 Pts. (1.8L)
AX5 (AISIN)	7.0 Pts. (3.3L)
T5 (Borg-Warner)	4.5 Pts. (2.1L)

Transfer Case	
1985-86	
Selec-Trac (229 Full-Time)	6.0 Pts. (2.8L)
Command-Trac (Part-Time 207)	4.5 Pts. (2.1L)
1987	
Selec-Trac	2.5 Pts. (1.2L)
Command-Trac	2.2 Pts. (1.0L)
1988	
Selec-Trac	3.0 Pts. (1.4L)
Command-Trac	2.2 Pts. (1.0L)
Drive Axles (3)	
Front	2.5 Pts. (1.2L)
Front (Disconnect Housing)	5.0 Ozs. (0.15L)
Rear	2.5 Pts. (1.2L)
Rear (Trac-Lok) (4)	2.5 Pts. (1.2L)

(1) - Capacities are recommended or calculated levels. Always use dipstick (if available) to measure level.
(2) - Includes 2.3 qts. for coolant recovery bottle.
(3) - Fill to bottom of filler plug hole.
(4) - Add 4 ozs. (118 ml) of Limited-Slip differential lubricant additive first, then add new fluid.

30,000 MILE (48,000 KM) SERVICE

30,000 MILE (48,000 KM) SERVICE

	Service Or Inspect
	Verify Last Major Service Was Performed
	Check Fluid Levels
	Check Cooling System Hoses and Clamps
	Check Coolant Strength
	Check Exhaust System & Heat Shielding
	Inspect Front Wheel Bearings (4WD)
	Clean Battery and Battery Terminals
	Adjust Drive Belt Tension
	Accessory Drive Belts
	Clean Choke Linkage
	Inspect C/V Joint boots (4WD)
	Inspect Underside of Vehicle (Bolts & Threaded Fasteners)
	Check/Lube Manual Steering Gear
	Check Drive Shaft Seals
	Lubricate Ball Joints, Steering Linkage & Suspension
	Lube Drive Shaft U-Joints and Slip Splines

	Lube Front Axle Drive Joint and Pivot Bearings (4WD)
	Suspension Bushings, Springs, Arms & Rear Jounce Bumpers
	Parking Brake System
	Lubricate Body Components
	Inspect Shocks for Leakage
	Inspect Tire Wear Pattern
	Rotate Tires and Adjust Air Pressure (Including Spare)
Replace	
	Engine Oil
	Oil Filter
	Spark Plugs
	Air Filter Element
	PCV Filter
	Fuel Filter

Lubrication Specifications

Application	Specification
Automatic Transmission	Dexron-IIE ATF
Brake Master Cylinder	DOT 3 (SAE J-1703F) Brake Fluid
Engine Coolant	Alugard 340-2 & Water (50/50 Mixture)
Engine Oil (1)	
Gasoline Engine	
Temperature Range	
Above 30° F (-1°C)	SAE 20W-40 Or 20W-50 API SH/CD
Above 0° F (-18°C)	SAE 10W-30 Or 10W-40 API SH/CD
Less Than 60° F (16°C)	SAE 5W-30 API SH/CD
Drive Axles	SAE 75W-90 API GL-5
Drive Axles (Trac-Lok) (2)	SAE 80W-140 API GL-5
Drive Axles (Trailer Towing)	SAE 80W-140 API GL-5
Hydraulic Clutch	DOT 3 (SAE J-1703F) Brake Fluid
Manual Transmission	SAE 75W-90 API GL-5
Parking Brake Cable Guides	NLGI Grade 2, GC-LB
Door & Hood Hinges	Light Engine Oil
Manual Steering Box	Multi-Purpose NLGI Grade 2EP
Power Steering Pump	Power Steering Fluid
Transfer Case	Dexron-IIE ATF
Brake Caliper Bushings	GE 661 or DOW 111 Silicone Grease
Caliper Slide Pins	GE 661 or DOW 111 Silicone Grease
Wheel Bearings	Multi-Purpose NLGI Grade GC-LB
Drive Shaft U-Joints	Multi-Purpose NLGI Grade 2EP
Steering Linkage (4)(5)	NLGI Grade 2, GC-LB
Ball Joints (4)(6)	NLGI Grade 2, GC-LB
Weatherstrip	Silicone Spray Lubricant
Wheel Lug Nut Torque	95 ft. lbs. (129 N.m)

(1) - SAE 10W-30 SH/CD is preferred.
(2) - Add 4 ozs. (118 ml) of Limited-Slip differential lubricant additive when changing fluid.

(3) - For vehicles operating under heavy-duty towing conditions, use SAE 75W-140 Synthetic lube.
NOTE: Before using SAE 75W-140 Synthetic the old fluid must be DRAINED and FLUSHED with clean mineral based axle lubricant. Then refill with new synthetic lube.
(4) - Use low pressure grease gun to prevent seal damage.
(5) - Fill until lubricant squeezes out from the base of seals.
(6) - Fill ball joint until seal starts to swell.

Fluid Capacities

Application	(1) Quantity
Automatic Transmission	
1984-86 (904 HD)	
Fluid Change	4.0 Qts. (3.8L)
Overhaul (Dry Fill)	8.0 Qts. (7.6L)
1987-88	
Fluid Change	4.0 Qts. (3.8L)
Overhaul (Dry Fill)	8.5 Qts. (8.0L)
Cooling System (2)	
4-Cylinder	10.0 Qts. (9.5L)
6-Cylinder	12.0 Qts. (11.4L)
Engine Oil	
4-Cylinder	4.0 Qts. (3.8L)
6-Cylinder	6.0 Qts. (5.7L)
Fuel Tank	
Standard	13.5 Gals. (51.1L)
Optional	20 Gals. (75.7L)
Manual Transmission (3)	
AX4 (AISIN)	7.4 Pts. (3.5L)
T4 (Borg-Warner)	3.9 Pts. (1.8L)
AX5 (AISIN)	7.0 Pts. (3.3L)
T5 (Borg-Warner)	4.5 Pts. (2.1L)
Transfer Case	
1985-86	
Selec-Trac (229 Full-Time)	6.0 Pts. (2.8L)
Command-Trac (Part-Time 207)	4.5 Pts. (2.1L)
1987	
Selec-Trac	2.5 Pts. (1.2L)
Command-Trac	2.2 Pts. (1.0L)
1988	
Selec-Trac	3.0 Pts. (1.4L)
Command-Trac	2.2 Pts. (1.0L)
Drive Axles (3)	
Front	2.5 Pts. (1.2L)
Front (Disconnect Housing)	5.0 Ozs. (0.15L)
Rear	2.5 Pts. (1.2L)
Rear (Trac-Lok) (4)	2.5 Pts. (1.2L)

(1) - Capacities are recommended or calculated levels. Always use dipstick (if available) to measure level.
(2) - Includes 2.3 qts. for coolant recovery bottle.
(3) - Fill to bottom of filler plug hole.
(4) - Add 4 ozs. (118 ml) of Limited-Slip differential lubricant additive first, then add new fluid.

Service Labor Times

Application	(1) Hours
2.5L	
Automatic Transmission	5.6

Manual Transmission	4.9
2.8L	
Automatic Transmission	5.8
Manual Transmission	5.1
4.0L	
Automatic Transmission	5.7
Manual Transmission	5.0

(1) - Add .8 hr. for vehicles equipped with 4WD.

37,500 MILE (60,000 KM) SERVICE

37,500 MILE (60,000 KM) SERVICE

Service Or Inspect	
	Verify Last Major Service Was Performed
	Check Fluid Levels
	Check Fuel Lines, Connections
	Check Cooling System Hoses and Clamps
	Check Exhaust System & Heat Shielding
	Inspect Brake System
	Inspect C/V Joint boots (4WD)
	Inspect Underside of Vehicle (Bolts & Threaded Fasteners)
	Check/Lube Manual Steering Gear
	Check Drive Shaft Seals
	Lubricate Ball Joints, Steering Linkage & Suspension
	Lube Drive Shaft U-Joints and Slip Splines
	Lube Front Axle Drive Joint and Pivot Bearings (4WD)
	Rotate Tires and Adjust Air Pressure (Including Spare)
Replace	
	Engine Oil
	Oil Filter, if it has not been changed in the last 12 months
	Manual Transmission Fluid
	Automatic Transmission Fluid, Filter and Adjust Bands
	Transfer Case Fluid

Lubrication Specifications

Application	Specification
Automatic Transmission	Dexron-IIE ATF

Brake Master Cylinder	DOT 3 (SAE J-1703F) Brake Fluid
Engine Coolant	Alugard 340-2 & Water (50/50 Mixture)
Engine Oil (1)	
Gasoline Engine	
Temperature Range	
Above 30° F (-1°C)	SAE 20W-40 Or 20W-50 API SH/CD
Above 0° F (-18°C)	SAE 10W-30 Or 10W-40 API SH/CD
Less Than 60° F (16°C)	SAE 5W-30 API SH/CD
Drive Axles	SAE 75W-90 API GL-5
Drive Axles (Trac-Lok) (2)	SAE 80W-140 API GL-5
Drive Axles (Trailer Towing)	SAE 80W-140 API GL-5
Hydraulic Clutch	DOT 3 (SAE J-1703F) Brake Fluid
Manual Transmission	SAE 75W-90 API GL-5
Parking Brake Cable Guides	NLGI Grade 2, GC-LB
Door & Hood Hinges	Light Engine Oil
Manual Steering Box	Multi-Purpose NLGI Grade 2EP
Power Steering Pump	Power Steering Fluid
Transfer Case	Dexron-IIE ATF
Brake Caliper Bushings	GE 661 or DOW 111 Silicone Grease
Caliper Slide Pins	GE 661 or DOW 111 Silicone Grease
Wheel Bearings	Multi-Purpose NLGI Grade GC-LB
Drive Shaft U-Joints	Multi-Purpose NLGI Grade 2EP
Steering Linkage (4)(5)	NLGI Grade 2, GC-LB
Ball Joints (4)(6)	NLGI Grade 2, GC-LB
Weatherstrip	Silicone Spray Lubricant
Wheel Lug Nut Torque	95 ft. lbs. (129 N.m)

(1) - SAE 10W-30 SH/CD is preferred.
(2) - Add 4 ozs. (118 ml) of Limited-Slip differential lubricant additive when changing fluid.
(3) - For vehicles operating under heavy-duty towing conditions, use SAE 75W-140 Synthetic lube.
NOTE: Before using SAE 75W-140 Synthetic the old fluid must be DRAINED and FLUSHED with clean mineral based axle lubricant. Then refill with new synthetic lube.
(4) - Use low pressure grease gun to prevent seal damage.
(5) - Fill until lubricant squeezes out from the base of seals.
(6) - Fill ball joint until seal starts to swell.

Fluid Capacities

Application	(1) Quantity
Automatic Transmission	
1984-86 (904 HD)	
Fluid Change	4.0 Qts. (3.8L)
Overhaul (Dry Fill)	8.0 Qts. (7.6L)
1987-88	
Fluid Change	4.0 Qts. (3.8L)
Overhaul (Dry Fill)	8.5 Qts. (8.0L)
Cooling System (2)	
4-Cylinder	10.0 Qts. (9.5L)
6-Cylinder	12.0 Qts. (11.4L)
Engine Oil	
4-Cylinder	4.0 Qts. (3.8L)
6-Cylinder	6.0 Qts. (5.7L)
Fuel Tank	
Standard	13.5 Gals. (51.1L)
Optional	20 Gals. (75.7L)
Manual Transmission (3)	
AX4 (AISIN)	7.4 Pts. (3.5L)
T4 (Borg-Warner)	3.9 Pts. (1.8L)
AX5 (AISIN)	7.0 Pts. (3.3L)

T5 (Borg-Warner)	4.5 Pts. (2.1L)
Transfer Case	
1985-86	
Selec-Trac (229 Full-Time)	6.0 Pts. (2.8L)
Command-Trac (Part-Time 207)	4.5 Pts. (2.1L)
1987	
Selec-Trac	2.5 Pts. (1.2L)
Command-Trac	2.2 Pts. (1.0L)
1988	
Selec-Trac	3.0 Pts. (1.4L)
Command-Trac	2.2 Pts. (1.0L)
Drive Axles (3)	
Front	2.5 Pts. (1.2L)
Front (Disconnect Housing)	5.0 Ozs. (0.15L)
Rear	2.5 Pts. (1.2L)
Rear (Trac-Lok) (4)	2.5 Pts. (1.2L)

(1) - Capacities are recommended or calculated levels. Always use dipstick (if available) to measure level.
(2) - Includes 2.3 qts. for coolant recovery bottle.
(3) - Fill to bottom of filler plug hole.
(4) - Add 4 ozs. (118 ml) of Limited-Slip differential lubricant additive first, then add new fluid.

45,000 MILE (72,000 KM) SERVICE

45,000 MILE (72,000 KM) SERVICE

	Service Or Inspect
	Verify Last Major Service Was Performed
	Check Fluid Levels
	Check Fuel Lines, Connections
	Check Cooling System Hoses and Clamps
	Check Coolant Strength
	Clean Battery and Battery Terminals
	Accessory Drive Belts
	Check Exhaust System & Heat Shielding
	Check Operation of Horn, Wipers/Washers & All Exterior Lights
	Inspect Condition of Wiper Blades
	Check Headlight Alignment
	Check Seat Belt Webbing and Release Mechanisms
	Check Parking Brake Operation
	Check Shift/Clutch Interlock Operation
	Inspect C/V Joint boots (4WD)
	Inspect Underside of Vehicle (Bolts & Threaded Fasteners)

	Check/Lube Manual Steering Gear
	Check Drive Shaft Seals
	Lubricate Ball Joints, Steering Linkage & Suspension
	Lube Drive Shaft U-Joints and Slip Splines
	Lube Front Axle Drive Joint and Pivot Bearings (4WD)
	Lube Parking Brake Ratio Lever Pivot
	Lube Manual Gearshift Control (4WD Transfer Case)
	Inspect/Repack Front Wheel Bearings (2WD Models)
	Inspect Front Brake Pads & Rotors
	Lubricate Caliper Slide Rails
	Inspect Rear Brake Linings & Drums
	Inspect Brake System Hoses & Lines
	Inspect Shocks for Leakage
	Inspect Tire Wear Pattern
	Lubricate Weatherstripping with Silicone
	Lubricate Door Hinges
	Lubricate Door Locks
	Check Body Drain Holes
	Rotate Tires and Adjust Air Pressure
	Replace
	Engine Oil
	Oil Filter
	Automatic Transmission Fluid, Filter and Adjust Bands
	Flush and Fill Engine Coolant, if not done in last 36 months
	Lubrication Specifications

Application	Specification
Automatic Transmission	Dexron-IIE ATF
Brake Master Cylinder	DOT 3 (SAE J-1703F) Brake Fluid
Engine Coolant	Alugard 340-2 & Water (50/50 Mixture)
Engine Oil (1)	
Gasoline Engine	
Temperature Range	
Above 30° F (-1°C)	SAE 20W-40 Or 20W-50 API SH/CD
Above 0° F (-18°C)	SAE 10W-30 Or 10W-40 API SH/CD
Less Than 60° F (16°C)	SAE 5W-30 API SH/CD
Drive Axles	SAE 75W-90 API GL-5

Drive Axles (Trac-Lok) (2)	SAE 80W-140 API GL-5
Drive Axles (Trailer Towing)	SAE 80W-140 API GL-5
Hydraulic Clutch	DOT 3 (SAE J-1703F) Brake Fluid
Manual Transmission	SAE 75W-90 API GL-5
Parking Brake Cable Guides	NLGI Grade 2, GC-LB
Door & Hood Hinges	Light Engine Oil
Manual Steering Box	Multi-Purpose NLGI Grade 2EP
Power Steering Pump	Power Steering Fluid
Transfer Case	Dexron-IIE ATF
Brake Caliper Bushings	GE 661 or DOW 111 Silicone Grease
Caliper Slide Pins	GE 661 or DOW 111 Silicone Grease
Wheel Bearings	Multi-Purpose NLGI Grade GC-LB
Drive Shaft U-Joints	Multi-Purpose NLGI Grade 2EP
Steering Linkage (4)(5)	NLGI Grade 2, GC-LB
Ball Joints (4)(6)	NLGI Grade 2, GC-LB
Weatherstrip	Silicone Spray Lubricant
Wheel Lug Nut Torque	95 ft. lbs. (129 N.m)

(1) - SAE 10W-30 SH/CD is preferred.
(2) - Add 4 ozs. (118 ml) of Limited-Slip differential lubricant additive when changing fluid.
(3) - For vehicles operating under heavy-duty towing conditions, use SAE 75W-140 Synthetic lube.
NOTE: Before using SAE 75W-140 Synthetic the old fluid must be DRAINED and FLUSHED with clean mineral based axle lubricant. Then refill with new synthetic lube.
(4) - Use low pressure grease gun to prevent seal damage.
(5) - Fill until lubricant squeezes out from the base of seals.
(6) - Fill ball joint until seal starts to swell.

Fluid Capacities

Application	(1) Quantity
Automatic Transmission	
1984-86 (904 HD)	
Fluid Change	4.0 Qts. (3.8L)
Overhaul (Dry Fill)	8.0 Qts. (7.6L)
1987-88	
Fluid Change	4.0 Qts. (3.8L)
Overhaul (Dry Fill)	8.5 Qts. (8.0L)
Cooling System (2)	
4-Cylinder	10.0 Qts. (9.5L)
6-Cylinder	12.0 Qts. (11.4L)
Engine Oil	
4-Cylinder	4.0 Qts. (3.8L)
6-Cylinder	6.0 Qts. (5.7L)
Fuel Tank	
Standard	13.5 Gals. (51.1L)
Optional	20 Gals. (75.7L)
Manual Transmission (3)	
AX4 (AISIN)	7.4 Pts. (3.5L)
T4 (Borg-Warner)	3.9 Pts. (1.8L)
AX5 (AISIN)	7.0 Pts. (3.3L)
T5 (Borg-Warner)	4.5 Pts. (2.1L)
Transfer Case	
1985-86	
Selec-Trac (229 Full-Time)	6.0 Pts. (2.8L)
Command-Trac (Part-Time 207)	4.5 Pts. (2.1L)
1987	
Selec-Trac	2.5 Pts. (1.2L)
Command-Trac	2.2 Pts. (1.0L)
1988	

Selec-Trac	3.0 Pts. (1.4L)
Command-Trac	2.2 Pts. (1.0L)
Drive Axles (3)	
Front	2.5 Pts. (1.2L)
Front (Disconnect Housing)	5.0 Ozs. (0.15L)
Rear	2.5 Pts. (1.2L)
Rear (Trac-Lok) (4)	2.5 Pts. (1.2L)

(1) - Capacities are recommended or calculated levels. Always use dipstick (if available) to measure level.
(2) - Includes 2.3 qts. for coolant recovery bottle.
(3) - Fill to bottom of filler plug hole.
(4) - Add 4 ozs. (118 ml) of Limited-Slip differential lubricant additive first, then add new fluid.

52,500 MILE (84,000 KM) SERVICE

52,500 MILE (84,000 KM) SERVICE

Service Or Inspect	
	Verify Last Major Service Was Performed
	Check Fluid Levels
	Check Fuel Lines, Connections
	Check Cooling System Hoses and Clamps
	Check Exhaust System & Heat Shielding
	Curb & Fast Idle Speed
	Clean Choke Linkage
	Ignition Timing
	Inspect Brake System
	Inspect C/V Joint boots (4WD)
	Inspect Underside of Vehicle (Bolts & Threaded Fasteners)
	Check/Lube Manual Steering Gear
	Check Drive Shaft Seals
	Lubricate Ball Joints, Steering Linkage & Suspension
	Lube Drive Shaft U-Joints and Slip Splines
	Lube Front Axle Drive Joint and Pivot Bearings (4WD)
	Rotate Tires and Adjust Air Pressure (Including Spare)
Replace	
	Engine Oil
	Oil Filter, if it has not been changed in the last 12 months

Flush and Fill Engine Coolant, if not done in last 36 months

Lubrication Specifications

Application	Specification
Automatic Transmission	Dexron-IIE ATF
Brake Master Cylinder	DOT 3 (SAE J-1703F) Brake Fluid
Engine Coolant	Alugard 340-2 & Water (50/50 Mixture)
Engine Oil (1)	
Gasoline Engine	
Temperature Range	
Above 30° F (-1°C)	SAE 20W-40 Or 20W-50 API SH/CD
Above 0° F (-18°C)	SAE 10W-30 Or 10W-40 API SH/CD
Less Than 60° F (16°C)	SAE 5W-30 API SH/CD
Drive Axles	SAE 75W-90 API GL-5
Drive Axles (Trac-Lok) (2)	SAE 80W-140 API GL-5
Drive Axles (Trailer Towing)	SAE 80W-140 API GL-5
Hydraulic Clutch	DOT 3 (SAE J-1703F) Brake Fluid
Manual Transmission	SAE 75W-90 API GL-5
Parking Brake Cable Guides	NLGI Grade 2, GC-LB
Door & Hood Hinges	Light Engine Oil
Manual Steering Box	Multi-Purpose NLGI Grade 2EP
Power Steering Pump	Power Steering Fluid
Transfer Case	Dexron-IIE ATF
Brake Caliper Bushings	GE 661 or DOW 111 Silicone Grease
Caliper Slide Pins	GE 661 or DOW 111 Silicone Grease
Wheel Bearings	Multi-Purpose NLGI Grade GC-LB
Drive Shaft U-Joints	Multi-Purpose NLGI Grade 2EP
Steering Linkage (4)(5)	NLGI Grade 2, GC-LB
Ball Joints (4)(6)	NLGI Grade 2, GC-LB
Weatherstrip	Silicone Spray Lubricant
Wheel Lug Nut Torque	95 ft. lbs. (129 N.m)

(1) - SAE 10W-30 SH/CD is preferred.
(2) - Add 4 ozs. (118 ml) of Limited-Slip differential lubricant additive when changing fluid.
(3) - For vehicles operating under heavy-duty towing conditions, use SAE 75W-140 Synthetic lube.
NOTE: Before using SAE 75W-140 Synthetic the old fluid must be DRAINED and FLUSHED with clean mineral based axle lubricant. Then refill with new synthetic lube.
(4) - Use low pressure grease gun to prevent seal damage.
(5) - Fill until lubricant squeezes out from the base of seals.
(6) - Fill ball joint until seal starts to swell.

Fluid Capacities

Application	(1) Quantity
Automatic Transmission	
1984-86 (904 HD)	
Fluid Change	4.0 Qts. (3.8L)
Overhaul (Dry Fill)	8.0 Qts. (7.6L)
1987-88	
Fluid Change	4.0 Qts. (3.8L)
Overhaul (Dry Fill)	8.5 Qts. (8.0L)
Cooling System (2)	
4-Cylinder	10.0 Qts. (9.5L)
6-Cylinder	12.0 Qts. (11.4L)
Engine Oil	
4-Cylinder	4.0 Qts. (3.8L)
6-Cylinder	6.0 Qts. (5.7L)

Fuel Tank	
Standard	13.5 Gals. (51.1L)
Optional	20 Gals. (75.7L)
Manual Transmission (3)	
AX4 (AISIN)	7.4 Pts. (3.5L)
T4 (Borg-Warner)	3.9 Pts. (1.8L)
AX5 (AISIN)	7.0 Pts. (3.3L)
T5 (Borg-Warner)	4.5 Pts. (2.1L)
Transfer Case	
1985-86	
Selec-Trac (229 Full-Time)	6.0 Pts. (2.8L)
Command-Trac (Part-Time 207)	4.5 Pts. (2.1L)
1987	
Selec-Trac	2.5 Pts. (1.2L)
Command-Trac	2.2 Pts. (1.0L)
1988	
Selec-Trac	3.0 Pts. (1.4L)
Command-Trac	2.2 Pts. (1.0L)
Drive Axles (3)	
Front	2.5 Pts. (1.2L)
Front (Disconnect Housing)	5.0 Ozs. (0.15L)
Rear	2.5 Pts. (1.2L)
Rear (Trac-Lok) (4)	2.5 Pts. (1.2L)

(1) - Capacities are recommended or calculated levels. Always use dipstick (if available) to measure level.
(2) - Includes 2.3 qts. for coolant recovery bottle.
(3) - Fill to bottom of filler plug hole.
(4) - Add 4 ozs. (118 ml) of Limited-Slip differential lubricant additive first, then add new fluid.

60,000 MILE (96,000 KM) SERVICE

60,000 MILE (96,000 KM) SERVICE

	Service Or Inspect
	Verify Last Major Service Was Performed
	Check Fluid Levels
	Check Cooling System Hoses and Clamps
	Check Coolant Strength
	Check Accessory Drive Belts
	Check Exhaust System & Heat Shielding
	Clean Battery and Battery Terminals
	Clean and Lubricate Crankcase Inlet Air Cleaner
	Inspect Brake System
	Inspect Exhaust System
	Adjust Drive Belt Tension
	Adjust Idle - Propane Method (1987-88 Carbureted Only)

		Choke Linkage
		Ignition Timing
		Lubricate Manifold Heat Control Valve (if equipped)
		Clean PCV Breather (if equipped)
		Clean EGR Passages (if equipped)
		Inspect C/V Joint boots (4WD)
		Inspect Underside of Vehicle (Bolts & Threaded Fasteners)
		Check/Lube Manual Steering Gear
		Check Drive Shaft Seals
		Lubricate Ball Joints, Steering Linkage & Suspension
		Lube Drive Shaft U-Joints and Slip Splines
		Lube Front Axle Drive Joint and Pivot Bearings (4WD)
		Inspect Front Wheel Bearings (4WD)
		Suspension Bushings, Springs, Arms & Rear Jounce Bumpers
		Parking Brake System
		Inspect Shocks for Leakage
		Inspect Tire Wear Pattern
		Rotate Tires and Adjust Air Pressure (Including Spare)
		Replace
		Engine Oil
		Oil Filter
		Spark Plugs
		Ignition Cables
		Distributor Cap and Rotor
		Air Filter Element
		EGR Valve & Tube (1987-92)
		Vacuum Operated Emission Components (1987-92)
		PCV Valve (1)
		Drive Belt (V-Type) (2)
		Flush and Fill Engine Coolant, if not done in last 24 months
		Automatic Transmission Fluid, Filter and Adjust Bands
		Accessory Drive Belts

	Fuel Filter
	Emission System Vacuum Hoses
	Ignition Wires
	Distributor Cap & Rotor
	Battery

(1) - Replacement is recommended by Chrysler at this time, but it is not required to maintain the warranty on the PCV valve.
(2) - Check and replace as needed.

Lubrication Specifications

Application	Specification
Automatic Transmission	Dexron-IIE ATF
Brake Master Cylinder	DOT 3 (SAE J-1703F) Brake Fluid
Engine Coolant	Alugard 340-2 & Water (50/50 Mixture)
Engine Oil (1)	
Gasoline Engine	
Temperature Range	
Above 30° F (-1°C)	SAE 20W-40 Or 20W-50 API SH/CD
Above 0° F (-18°C)	SAE 10W-30 Or 10W-40 API SH/CD
Less Than 60° F (16°C)	SAE 5W-30 API SH/CD
Drive Axles	SAE 75W-90 API GL-5
Drive Axles (Trac-Lok) (2)	SAE 80W-140 API GL-5
Drive Axles (Trailer Towing)	SAE 80W-140 API GL-5
Hydraulic Clutch	DOT 3 (SAE J-1703F) Brake Fluid
Manual Transmission	SAE 75W-90 API GL-5
Parking Brake Cable Guides	NLGI Grade 2, GC-LB
Door & Hood Hinges	Light Engine Oil
Manual Steering Box	Multi-Purpose NLGI Grade 2EP
Power Steering Pump	Power Steering Fluid
Transfer Case	Dexron-IIE ATF
Brake Caliper Bushings	GE 661 or DOW 111 Silicone Grease
Caliper Slide Pins	GE 661 or DOW 111 Silicone Grease
Wheel Bearings	Multi-Purpose NLGI Grade GC-LB
Drive Shaft U-Joints	Multi-Purpose NLGI Grade 2EP
Steering Linkage (4)(5)	NLGI Grade 2, GC-LB
Ball Joints (4)(6)	NLGI Grade 2, GC-LB
Weatherstrip	Silicone Spray Lubricant
Wheel Lug Nut Torque	95 ft. lbs. (129 N.m)

(1) - SAE 10W-30 SH/CD is preferred.
(2) - Add 4 ozs. (118 ml) of Limited-Slip differential lubricant additive when changing fluid.
(3) - For vehicles operating under heavy-duty towing conditions, use SAE 75W-140 Synthetic lube.
NOTE: Before using SAE 75W-140 Synthetic the old fluid must be DRAINED and FLUSHED with clean mineral based axle lubricant. Then refill with new synthetic lube.
(4) - Use low pressure grease gun to prevent seal damage.
(5) - Fill until lubricant squeezes out from the base of seals.
(6) - Fill ball joint until seal starts to swell.

Fluid Capacities

Application	(1) Quantity

Automatic Transmission	
1984-86 (904 HD)	
Fluid Change	4.0 Qts. (3.8L)
Overhaul (Dry Fill)	8.0 Qts. (7.6L)
1987-88	
Fluid Change	4.0 Qts. (3.8L)
Overhaul (Dry Fill)	8.5 Qts. (8.0L)
Cooling System (2)	
4-Cylinder	10.0 Qts. (9.5L)
6-Cylinder	12.0 Qts. (11.4L)
Engine Oil	
4-Cylinder	4.0 Qts. (3.8L)
6-Cylinder	6.0 Qts. (5.7L)
Fuel Tank	
Standard	13.5 Gals. (51.1L)
Optional	20 Gals. (75.7L)
Manual Transmission (3)	
AX4 (AISIN)	7.4 Pts. (3.5L)
T4 (Borg-Warner)	3.9 Pts. (1.8L)
AX5 (AISIN)	7.0 Pts. (3.3L)
T5 (Borg-Warner)	4.5 Pts. (2.1L)
Transfer Case	
1985-86	
Selec-Trac (229 Full-Time)	6.0 Pts. (2.8L)
Command-Trac (Part-Time 207)	4.5 Pts. (2.1L)
1987	
Selec-Trac	2.5 Pts. (1.2L)
Command-Trac	2.2 Pts. (1.0L)
1988	
Selec-Trac	3.0 Pts. (1.4L)
Command-Trac	2.2 Pts. (1.0L)
Drive Axles (3)	
Front	2.5 Pts. (1.2L)
Front (Disconnect Housing)	5.0 Ozs. (0.15L)
Rear	2.5 Pts. (1.2L)
Rear (Trac-Lok) (4)	2.5 Pts. (1.2L)

(1) - Capacities are recommended or calculated levels. Always use dipstick (if available) to measure level.
(2) - Includes 2.3 qts. for coolant recovery bottle.
(3) - Fill to bottom of filler plug hole.
(4) - Add 4 ozs. (118 ml) of Limited-Slip differential lubricant additive first, then add new fluid.

Service Labor Times

Application	Hours
2.5L	
Automatic Transmission	3.5
Manual Transmission	3.5
2.8L	
Automatic Transmission	3.7
Manual Transmission	3.7
4.0L	
Automatic Transmission	3.6
Manual Transmission	3.6

67,500 MILE (108,000 KM) SERVICE

67,500 MILE (108,000 KM) SERVICE

Service Or Inspect	
	Verify Last Major Service Was Performed
	Check Fluid Levels
	Check Fuel Lines, Connections
	Check Cooling System Hoses and Clamps
	Check Exhaust System & Heat Shielding
	Inspect C/V Joint boots (4WD)
	Inspect Underside of Vehicle (Bolts & Threaded Fasteners)
	Check/Lube Manual Steering Gear
	Check Drive Shaft Seals
	Lubricate Ball Joints, Steering Linkage & Suspension
	Lube Drive Shaft U-Joints and Slip Splines
	Lube Front Axle Drive Joint and Pivot Bearings (4WD)
	Lube Parking Brake Ratio Lever Pivot
	Lube Manual Gearshift Control (4WD Transfer Case)
	Inspect/Repack Front Wheel Bearings (2WD Models)
	Inspect Front Brake Pads & Rotors
	Lubricate Caliper Slide Rails
	Inspect Rear Brake Linings & Drums
	Inspect Brake System Hoses & Lines
	Inspect Shocks for Leakage
	Inspect Tire Wear Pattern
	Rotate Tires and Adjust Air Pressure (Including Spare)
Replace	
	Engine Oil
	Oil Filter, if it has not been changed in the last 12 months
Lubrication Specifications	

Application	Specification
Automatic Transmission	Dexron-IIE ATF
Brake Master Cylinder	DOT 3 (SAE J-1703F) Brake Fluid
Engine Coolant	Alugard 340-2 & Water (50/50 Mixture)
Engine Oil (1)	
Gasoline Engine	
Temperature Range	

Above 30° F (-1°C)	SAE 20W-40 Or 20W-50 API SH/CD
Above 0° F (-18°C)	SAE 10W-30 Or 10W-40 API SH/CD
Less Than 60° F (16°C)	SAE 5W-30 API SH/CD
Drive Axles	SAE 75W-90 API GL-5
Drive Axles (Trac-Lok) (2)	SAE 80W-140 API GL-5
Drive Axles (Trailer Towing)	SAE 80W-140 API GL-5
Hydraulic Clutch	DOT 3 (SAE J-1703F) Brake Fluid
Manual Transmission	SAE 75W-90 API GL-5
Parking Brake Cable Guides	NLGI Grade 2, GC-LB
Door & Hood Hinges	Light Engine Oil
Manual Steering Box	Multi-Purpose NLGI Grade 2EP
Power Steering Pump	Power Steering Fluid
Transfer Case	Dexron-IIE ATF
Brake Caliper Bushings	GE 661 or DOW 111 Silicone Grease
Caliper Slide Pins	GE 661 or DOW 111 Silicone Grease
Wheel Bearings	Multi-Purpose NLGI Grade GC-LB
Drive Shaft U-Joints	Multi-Purpose NLGI Grade 2EP
Steering Linkage (4)(5)	NLGI Grade 2, GC-LB
Ball Joints (4)(6)	NLGI Grade 2, GC-LB
Weatherstrip	Silicone Spray Lubricant
Wheel Lug Nut Torque	95 ft. lbs. (129 N.m)

(1) - SAE 10W-30 SH/CD is preferred.
(2) - Add 4 ozs. (118 ml) of Limited-Slip differential lubricant additive when changing fluid.
(3) - For vehicles operating under heavy-duty towing conditions, use SAE 75W-140 Synthetic lube.
NOTE: Before using SAE 75W-140 Synthetic the old fluid must be DRAINED and FLUSHED with clean mineral based axle lubricant. Then refill with new synthetic lube.
(4) - Use low pressure grease gun to prevent seal damage.
(5) - Fill until lubricant squeezes out from the base of seals.
(6) - Fill ball joint until seal starts to swell.

Fluid Capacities

Application	(1) Quantity
Automatic Transmission	
1984-86 (904 HD)	
Fluid Change	4.0 Qts. (3.8L)
Overhaul (Dry Fill)	8.0 Qts. (7.6L)
1987-88	
Fluid Change	4.0 Qts. (3.8L)
Overhaul (Dry Fill)	8.5 Qts. (8.0L)
Cooling System (2)	
4-Cylinder	10.0 Qts. (9.5L)
6-Cylinder	12.0 Qts. (11.4L)
Engine Oil	
4-Cylinder	4.0 Qts. (3.8L)
6-Cylinder	6.0 Qts. (5.7L)
Fuel Tank	
Standard	13.5 Gals. (51.1L)
Optional	20 Gals. (75.7L)
Manual Transmission (3)	
AX4 (AISIN)	7.4 Pts. (3.5L)
T4 (Borg-Warner)	3.9 Pts. (1.8L)
AX5 (AISIN)	7.0 Pts. (3.3L)
T5 (Borg-Warner)	4.5 Pts. (2.1L)
Transfer Case	
1985-86	
Selec-Trac (229 Full-Time)	6.0 Pts. (2.8L)
Command-Trac (Part-Time 207)	4.5 Pts. (2.1L)

1987	
Selec-Trac	2.5 Pts. (1.2L)
Command-Trac	2.2 Pts. (1.0L)
1988	
Selec-Trac	3.0 Pts. (1.4L)
Command-Trac	2.2 Pts. (1.0L)
Drive Axles (3)	
Front	2.5 Pts. (1.2L)
Front (Disconnect Housing)	5.0 Ozs. (0.15L)
Rear	2.5 Pts. (1.2L)
Rear (Trac-Lok) (4)	2.5 Pts. (1.2L)

(1) - Capacities are recommended or calculated levels. Always use dipstick (if available) to measure level.
(2) - Includes 2.3 qts. for coolant recovery bottle.
(3) - Fill to bottom of filler plug hole.
(4) - Add 4 ozs. (118 ml) of Limited-Slip differential lubricant additive first, then add new fluid.

75,000 MILE (120,000 KM) SERVICE

75,000 MILE (120,000 KM) SERVICE

	Service Or Inspect
	Verify Last Major Service Was Performed
	Check Fluid Levels
	Check Fuel Lines, Connections
	Check Cooling System Hoses and Clamps
	Check Coolant Strength
	Check Exhaust System & Heat Shielding
	Clean Battery and Battery Terminals
	Adjust Drive Belt Tension
	Inspect Brake System
	Check Operation of Horn, Wipers/Washers & All Exterior Lights
	Inspect Condition of Wiper Blades
	Check Headlight Alignment
	Check Seat Belt Webbing and Release Mechanisms
	Check Parking Brake Operation
	Check Shift/Clutch Interlock Operation
	Inspect C/V Joint boots (4WD)
	Inspect Underside of Vehicle (Bolts & Threaded Fasteners)
	Check/Lube Manual Steering Gear

	Check Drive Shaft Seals
	Lubricate Ball Joints, Steering Linkage & Suspension
	Lube Drive Shaft U-Joints and Slip Splines
	Lube Front Axle Drive Joint and Pivot Bearings (4WD)
	Lubricate Weatherstripping with Silicone
	Lubricate Door Hinges
	Lubricate Door Locks
	Check Body Drain Holes
	Rotate Tires and Adjust Air Pressure
	Replace
	Engine Oil
	Oil Filter
	Manual Transmission Fluid
	Automatic Transmission Fluid, Filter and Adjust Bands
	Transfer Case Fluid
	Flush and Fill Engine Coolant, if not done in last 24 months
	Lubrication Specifications

Application	Specification
Automatic Transmission	Dexron-IIE ATF
Brake Master Cylinder	DOT 3 (SAE J-1703F) Brake Fluid
Engine Coolant	Alugard 340-2 & Water (50/50 Mixture)
Engine Oil (1)	
Gasoline Engine	
Temperature Range	
Above 30° F (-1°C)	SAE 20W-40 Or 20W-50 API SH/CD
Above 0° F (-18°C)	SAE 10W-30 Or 10W-40 API SH/CD
Less Than 60° F (16°C)	SAE 5W-30 API SH/CD
Drive Axles	SAE 75W-90 API GL-5
Drive Axles (Trac-Lok) (2)	SAE 80W-140 API GL-5
Drive Axles (Trailer Towing)	SAE 80W-140 API GL-5
Hydraulic Clutch	DOT 3 (SAE J-1703F) Brake Fluid
Manual Transmission	SAE 75W-90 API GL-5
Parking Brake Cable Guides	NLGI Grade 2, GC-LB
Door & Hood Hinges	Light Engine Oil
Manual Steering Box	Multi-Purpose NLGI Grade 2EP
Power Steering Pump	Power Steering Fluid
Transfer Case	Dexron-IIE ATF
Brake Caliper Bushings	GE 661 or DOW 111 Silicone Grease
Caliper Slide Pins	GE 661 or DOW 111 Silicone Grease
Wheel Bearings	Multi-Purpose NLGI Grade GC-LB
Drive Shaft U-Joints	Multi-Purpose NLGI Grade 2EP
Steering Linkage (4)(5)	NLGI Grade 2, GC-LB
Ball Joints (4)(6)	NLGI Grade 2, GC-LB
Weatherstrip	Silicone Spray Lubricant
Wheel Lug Nut Torque	95 ft. lbs. (129 N.m)

(1) - SAE 10W-30 SH/CD is preferred.
(2) - Add 4 ozs. (118 ml) of Limited-Slip differential lubricant additive when changing fluid.
(3) - For vehicles operating under heavy-duty towing conditions, use SAE 75W-140 Synthetic lube.
NOTE: Before using SAE 75W-140 Synthetic the old fluid must be DRAINED and FLUSHED with clean mineral based axle lubricant. Then refill with new synthetic lube.
(4) - Use low pressure grease gun to prevent seal damage.
(5) - Fill until lubricant squeezes out from the base of seals.
(6) - Fill ball joint until seal starts to swell.

Fluid Capacities

Application	(1) Quantity
Automatic Transmission	
1984-86 (904 HD)	
Fluid Change	4.0 Qts. (3.8L)
Overhaul (Dry Fill)	8.0 Qts. (7.6L)
1987-88	
Fluid Change	4.0 Qts. (3.8L)
Overhaul (Dry Fill)	8.5 Qts. (8.0L)
Cooling System (2)	
4-Cylinder	10.0 Qts. (9.5L)
6-Cylinder	12.0 Qts. (11.4L)
Engine Oil	
4-Cylinder	4.0 Qts. (3.8L)
6-Cylinder	6.0 Qts. (5.7L)
Fuel Tank	
Standard	13.5 Gals. (51.1L)
Optional	20 Gals. (75.7L)
Manual Transmission (3)	
AX4 (AISIN)	7.4 Pts. (3.5L)
T4 (Borg-Warner)	3.9 Pts. (1.8L)
AX5 (AISIN)	7.0 Pts. (3.3L)
T5 (Borg-Warner)	4.5 Pts. (2.1L)
Transfer Case	
1985-86	
Selec-Trac (229 Full-Time)	6.0 Pts. (2.8L)
Command-Trac (Part-Time 207)	4.5 Pts. (2.1L)
1987	
Selec-Trac	2.5 Pts. (1.2L)
Command-Trac	2.2 Pts. (1.0L)
1988	
Selec-Trac	3.0 Pts. (1.4L)
Command-Trac	2.2 Pts. (1.0L)
Drive Axles (3)	
Front	2.5 Pts. (1.2L)
Front (Disconnect Housing)	5.0 Ozs. (0.15L)
Rear	2.5 Pts. (1.2L)
Rear (Trac-Lok) (4)	2.5 Pts. (1.2L)

(1) - Capacities are recommended or calculated levels. Always use dipstick (if available) to measure level.
(2) - Includes 2.3 qts. for coolant recovery bottle.
(3) - Fill to bottom of filler plug hole.
(4) - Add 4 ozs. (118 ml) of Limited-Slip differential lubricant additive first, then add new fluid.

82,500 MILE (132,000 KM) SERVICE

82,500 MILE (132,000 KM) SERVICE

Service Or Inspect	
	Verify Last Major Service Was Performed
	Check Fluid Levels
	Check Cooling System Hoses and Clamps
	Check Exhaust System & Heat Shielding
	Inspect Brake System
	Inspect C/V Joint boots (4WD)
	Inspect Underside of Vehicle (Bolts & Threaded Fasteners)
	Check/Lube Manual Steering Gear
	Check Drive Shaft Seals
	Lubricate Ball Joints, Steering Linkage & Suspension
	Lube Drive Shaft U-Joints and Slip Splines
	Lube Front Axle Drive Joint and Pivot Bearings (4WD)
	Rotate Tires and Adjust Air Pressure (Including Spare)
Replace	
	Engine Oil
	Oil Filter, if it has not been changed in the last 12 months
	O2 Sensor (1987-89)
	Flush and Fill Engine Coolant, if not done in last 24 months

Lubrication Specifications

Application	Specification
Automatic Transmission	Dexron-IIE ATF
Brake Master Cylinder	DOT 3 (SAE J-1703F) Brake Fluid
Engine Coolant	Alugard 340-2 & Water (50/50 Mixture)
Engine Oil (1)	
Gasoline Engine	
Temperature Range	
Above 30° F (-1°C)	SAE 20W-40 Or 20W-50 API SH/CD
Above 0° F (-18°C)	SAE 10W-30 Or 10W-40 API SH/CD
Less Than 60° F (16°C)	SAE 5W-30 API SH/CD
Drive Axles	SAE 75W-90 API GL-5
Drive Axles (Trac-Lok) (2)	SAE 80W-140 API GL-5
Drive Axles (Trailer Towing)	SAE 80W-140 API GL-5
Hydraulic Clutch	DOT 3 (SAE J-1703F) Brake Fluid
Manual Transmission	SAE 75W-90 API GL-5
Parking Brake Cable Guides	NLGI Grade 2, GC-LB
Door & Hood Hinges	Light Engine Oil

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Manual Steering Box  ..............  Multi-Purpose NLGI Grade 2EP
Power Steering Pump  ......................  Power Steering Fluid
Transfer Case  ...................................  Dexron-IIE ATF
Brake Caliper Bushings ........  GE 661 or DOW 111 Silicone Grease
Caliper Slide Pins  ..........  GE 661 or DOW 111 Silicone Grease
Wheel Bearings  .................  Multi-Purpose NLGI Grade GC-LB
Drive Shaft U-Joints  .............  Multi-Purpose NLGI Grade 2EP
Steering Linkage (4)(5)  ...................  NLGI Grade 2, GC-LB
Ball Joints (4)(6)  ........................  NLGI Grade 2, GC-LB
Weatherstrip  ........................  Silicone Spray Lubricant
Wheel Lug Nut Torque ....................  95 ft. lbs. (129 N.m)

(1) - SAE 10W-30 SH/CD is preferred.
(2) - Add 4 ozs. (118 ml) of Limited-Slip differential lubricant
      additive when changing fluid.
(3) - For vehicles operating under heavy-duty towing conditions,
      use SAE 75W-140 Synthetic lube.
      NOTE: Before using SAE 75W-140 Synthetic the old fluid must
      be DRAINED and FLUSHED with clean mineral based axle
      lubricant. Then refill with new synthetic lube.
(4) - Use low pressure grease gun to prevent seal damage.
(5) - Fill until lubricant squeezes out from the base of seals.
(6) - Fill ball joint until seal starts to swell.
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Fluid Capacities

```
Application                                            (1) Quantity

Automatic Transmission
  1984-86 (904 HD)
    Fluid Change  ...............................  4.0 Qts. (3.8L)
    Overhaul (Dry Fill)  ........................  8.0 Qts. (7.6L)
  1987-88
    Fluid Change  ...............................  4.0 Qts. (3.8L)
    Overhaul (Dry Fill)  ........................  8.5 Qts. (8.0L)
Cooling System (2)
  4-Cylinder  .................................  10.0 Qts. (9.5L)
  6-Cylinder  ................................  12.0 Qts. (11.4L)
Engine Oil
  4-Cylinder  ...................................  4.0 Qts. (3.8L)
  6-Cylinder  ...................................  6.0 Qts. (5.7L)
Fuel Tank
  Standard  ...............................  13.5 Gals. (51.1L)
  Optional  .................................  20 Gals. (75.7L)
Manual Transmission (3)
  AX4 (AISIN)  ..................................  7.4 Pts. (3.5L)
  T4 (Borg-Warner)  .............................  3.9 Pts. (1.8L)
  AX5 (AISIN)  ..................................  7.0 Pts. (3.3L)
  T5 (Borg-Warner)  .............................  4.5 Pts. (2.1L)
Transfer Case
  1985-86
    Selec-Trac (229 Full-Time)  .................  6.0 Pts. (2.8L)
    Command-Trac (Part-Time 207)  ...............  4.5 Pts. (2.1L)
  1987
    Selec-Trac  .................................  2.5 Pts. (1.2L)
    Command-Trac  ...............................  2.2 Pts. (1.0L)
  1988
    Selec-Trac  .................................  3.0 Pts. (1.4L)
    Command-Trac  ...............................  2.2 Pts. (1.0L)
Drive Axles (3)
  Front  ........................................  2.5 Pts. (1.2L)
  Front (Disconnect Housing)  ..................  5.0 Ozs. (0.15L)
  Rear  .........................................  2.5 Pts. (1.2L)
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Rear (Trac-Lok) (4)	2.5 Pts. (1.2L)

(1) - Capacities are recommended or calculated levels. Always use dipstick (if available) to measure level.
(2) - Includes 2.3 qts. for coolant recovery bottle.
(3) - Fill to bottom of filler plug hole.
(4) - Add 4 ozs. (118 ml) of Limited-Slip differential lubricant additive first, then add new fluid.

90,000 MILE (144,000 KM) SERVICE

90,000 MILE (144,000 KM) SERVICE

	Service Or Inspect
	Verify Last Major Service Was Performed
	Check Fluid Levels
	Check Fuel Lines, Connections
	Check Cooling System Hoses and Clamps
	Check Coolant Strength
	Clean Battery and Battery Terminals
	Accessory Drive Belts
	Clean Choke Linkage
	Check Exhaust System & Heat Shielding
	Check Operation of Horn, Wipers/Washers & All Exterior Lights
	Inspect Condition of Wiper Blades
	Check Headlight Alignment
	Check Seat Belt Webbing and Release Mechanisms
	Check Parking Brake Operation
	Check Shift/Clutch Interlock Operation
	Adjust Drive Belt Tension
	Inspect C/V Joint boots (4WD)
	Inspect Underside of Vehicle (Bolts & Threaded Fasteners)
	Check/Lube Manual Steering Gear
	Check Drive Shaft Seals
	Lubricate Ball Joints, Steering Linkage & Suspension
	Lube Drive Shaft U-Joints and Slip Splines
	Lube Front Axle Drive Joint and Pivot Bearings (4WD)

	Lube Parking Brake Ratio Lever Pivot
	Lube Manual Gearshift Control (4WD Transfer Case)
	Inspect/Repack Front Wheel Bearings (2WD Models)
	Inspect Front Brake Pads & Rotors
	Lubricate Caliper Slide Rails
	Inspect Rear Brake Linings & Drums
	Inspect Brake System Hoses & Lines
	Inspect Shocks for Leakage
	Inspect Tire Wear Pattern
	Lubricate Weatherstripping with Silicone
	Lubricate Door Hinges
	Lubricate Door Locks
	Check Body Drain Holes
	Rotate Tires and Adjust Air Pressure
	Replace
	Engine Oil
	Oil Filter
	Air Filter Element
	Fuel Filter
	Spark Plugs
	Automatic Transmission Fluid, Filter and Adjust Bands
	PCV Filter
	PCV Valve (1) (2)
	Drive Belt (V-Type) (2) (3)

(1) - Replacement is recommended by Chrysler at this time, but it is not required to maintain the warranty on the PCV valve.
(2) - Not required, if belt or PCV Valve was previously replaced
(3) - Check and replace as needed.

Lubrication Specifications

Application	Specification
Automatic Transmission	Dexron-IIE ATF
Brake Master Cylinder	DOT 3 (SAE J-1703F) Brake Fluid
Engine Coolant	Alugard 340-2 & Water (50/50 Mixture)
Engine Oil (1)	
Gasoline Engine	
Temperature Range	

Above 30° F (-1°C)	SAE 20W-40 Or 20W-50 API SH/CD
Above 0° F (-18°C)	SAE 10W-30 Or 10W-40 API SH/CD
Less Than 60° F (16°C)	SAE 5W-30 API SH/CD
Drive Axles	SAE 75W-90 API GL-5
Drive Axles (Trac-Lok) (2)	SAE 80W-140 API GL-5
Drive Axles (Trailer Towing)	SAE 80W-140 API GL-5
Hydraulic Clutch	DOT 3 (SAE J-1703F) Brake Fluid
Manual Transmission	SAE 75W-90 API GL-5
Parking Brake Cable Guides	NLGI Grade 2, GC-LB
Door & Hood Hinges	Light Engine Oil
Manual Steering Box	Multi-Purpose NLGI Grade 2EP
Power Steering Pump	Power Steering Fluid
Transfer Case	Dexron-IIE ATF
Brake Caliper Bushings	GE 661 or DOW 111 Silicone Grease
Caliper Slide Pins	GE 661 or DOW 111 Silicone Grease
Wheel Bearings	Multi-Purpose NLGI Grade GC-LB
Drive Shaft U-Joints	Multi-Purpose NLGI Grade 2EP
Steering Linkage (4)(5)	NLGI Grade 2, GC-LB
Ball Joints (4)(6)	NLGI Grade 2, GC-LB
Weatherstrip	Silicone Spray Lubricant
Wheel Lug Nut Torque	95 ft. lbs. (129 N.m)

(1) - SAE 10W-30 SH/CD is preferred.
(2) - Add 4 ozs. (118 ml) of Limited-Slip differential lubricant additive when changing fluid.
(3) - For vehicles operating under heavy-duty towing conditions, use SAE 75W-140 Synthetic lube.
NOTE: Before using SAE 75W-140 Synthetic the old fluid must be DRAINED and FLUSHED with clean mineral based axle lubricant. Then refill with new synthetic lube.
(4) - Use low pressure grease gun to prevent seal damage.
(5) - Fill until lubricant squeezes out from the base of seals.
(6) - Fill ball joint until seal starts to swell.

Fluid Capacities

Application	(1) Quantity
Automatic Transmission	
1984-86 (904 HD)	
Fluid Change	4.0 Qts. (3.8L)
Overhaul (Dry Fill)	8.0 Qts. (7.6L)
1987-88	
Fluid Change	4.0 Qts. (3.8L)
Overhaul (Dry Fill)	8.5 Qts. (8.0L)
Cooling System (2)	
4-Cylinder	10.0 Qts. (9.5L)
6-Cylinder	12.0 Qts. (11.4L)
Engine Oil	
4-Cylinder	4.0 Qts. (3.8L)
6-Cylinder	6.0 Qts. (5.7L)
Fuel Tank	
Standard	13.5 Gals. (51.1L)
Optional	20 Gals. (75.7L)
Manual Transmission (3)	
AX4 (AISIN)	7.4 Pts. (3.5L)
T4 (Borg-Warner)	3.9 Pts. (1.8L)
AX5 (AISIN)	7.0 Pts. (3.3L)
T5 (Borg-Warner)	4.5 Pts. (2.1L)
Transfer Case	
1985-86	
Selec-Trac (229 Full-Time)	6.0 Pts. (2.8L)
Command-Trac (Part-Time 207)	4.5 Pts. (2.1L)

1987	
Selec-Trac	2.5 Pts. (1.2L)
Command-Trac	2.2 Pts. (1.0L)
1988	
Selec-Trac	3.0 Pts. (1.4L)
Command-Trac	2.2 Pts. (1.0L)
Drive Axles (3)	
Front	2.5 Pts. (1.2L)
Front (Disconnect Housing)	5.0 Ozs. (0.15L)
Rear	2.5 Pts. (1.2L)
Rear (Trac-Lok) (4)	2.5 Pts. (1.2L)

(1) - Capacities are recommended or calculated levels. Always use dipstick (if available) to measure level.
(2) - Includes 2.3 qts. for coolant recovery bottle.
(3) - Fill to bottom of filler plug hole.
(4) - Add 4 ozs. (118 ml) of Limited-Slip differential lubricant additive first, then add new fluid.

Service Labor Times

Application	(1) Hours
2.5L	
Automatic Transmission	5.6
Manual Transmission	4.9
2.8L	
Automatic Transmission	5.8
Manual Transmission	5.1
4.0L	
Automatic Transmission	5.7
Manual Transmission	5.0

(1) - Add .8 hr. for vehicles equipped with 4WD.

97,500 MILE (156,000 KM) SERVICE

97,500 MILE (156,000 KM) SERVICE

	Service Or Inspect
	Verify Last Major Service Was Performed
	Check Fluid Levels
	Check Cooling System Hoses and Clamps
	Check Exhaust System & Heat Shielding
	Inspect Brake System
	Inspect Front Wheel Bearings
	Inspect C/V Joint boots (4WD)
	Inspect Underside of Vehicle (Bolts & Threaded Fasteners)
	Check/Lube Manual Steering Gear
	Check Drive Shaft Seals

	Lubricate Ball Joints, Steering Linkage & Suspension
	Lube Drive Shaft U-Joints and Slip Splines
	Lube Front Axle Drive Joint and Pivot Bearings (4WD)
	Rotate Tires and Adjust Air Pressure (Including Spare)
Replace	
	Engine Oil
	Oil Filter, if it has not been changed in the last 12 months

Lubrication Specifications

Application	Specification
Automatic Transmission	Dexron-IIE ATF
Brake Master Cylinder	DOT 3 (SAE J-1703F) Brake Fluid
Engine Coolant	Alugard 340-2 & Water (50/50 Mixture)
Engine Oil (1)	
Gasoline Engine	
Temperature Range	
Above 30° F (-1°C)	SAE 20W-40 Or 20W-50 API SH/CD
Above 0° F (-18°C)	SAE 10W-30 Or 10W-40 API SH/CD
Less Than 60° F (16°C)	SAE 5W-30 API SH/CD
Drive Axles	SAE 75W-90 API GL-5
Drive Axles (Trac-Lok) (2)	SAE 80W-140 API GL-5
Drive Axles (Trailer Towing)	SAE 80W-140 API GL-5
Hydraulic Clutch	DOT 3 (SAE J-1703F) Brake Fluid
Manual Transmission	SAE 75W-90 API GL-5
Parking Brake Cable Guides	NLGI Grade 2, GC-LB
Door & Hood Hinges	Light Engine Oil
Manual Steering Box	Multi-Purpose NLGI Grade 2EP
Power Steering Pump	Power Steering Fluid
Transfer Case	Dexron-IIE ATF
Brake Caliper Bushings	GE 661 or DOW 111 Silicone Grease
Caliper Slide Pins	GE 661 or DOW 111 Silicone Grease
Wheel Bearings	Multi-Purpose NLGI Grade GC-LB
Drive Shaft U-Joints	Multi-Purpose NLGI Grade 2EP
Steering Linkage (4)(5)	NLGI Grade 2, GC-LB
Ball Joints (4)(6)	NLGI Grade 2, GC-LB
Weatherstrip	Silicone Spray Lubricant
Wheel Lug Nut Torque	95 ft. lbs. (129 N.m)

(1) - SAE 10W-30 SH/CD is preferred.
(2) - Add 4 ozs. (118 ml) of Limited-Slip differential lubricant additive when changing fluid.
(3) - For vehicles operating under heavy-duty towing conditions, use SAE 75W-140 Synthetic lube.
NOTE: Before using SAE 75W-140 Synthetic the old fluid must be DRAINED and FLUSHED with clean mineral based axle lubricant. Then refill with new synthetic lube.
(4) - Use low pressure grease gun to prevent seal damage.
(5) - Fill until lubricant squeezes out from the base of seals.
(6) - Fill ball joint until seal starts to swell.

Fluid Capacities

Application	(1) Quantity
Automatic Transmission	

1984-86 (904 HD)	
Fluid Change	4.0 Qts. (3.8L)
Overhaul (Dry Fill)	8.0 Qts. (7.6L)
1987-88	
Fluid Change	4.0 Qts. (3.8L)
Overhaul (Dry Fill)	8.5 Qts. (8.0L)
Cooling System (2)	
4-Cylinder	10.0 Qts. (9.5L)
6-Cylinder	12.0 Qts. (11.4L)
Engine Oil	
4-Cylinder	4.0 Qts. (3.8L)
6-Cylinder	6.0 Qts. (5.7L)
Fuel Tank	
Standard	13.5 Gals. (51.1L)
Optional	20 Gals. (75.7L)
Manual Transmission (3)	
AX4 (AISIN)	7.4 Pts. (3.5L)
T4 (Borg-Warner)	3.9 Pts. (1.8L)
AX5 (AISIN)	7.0 Pts. (3.3L)
T5 (Borg-Warner)	4.5 Pts. (2.1L)
Transfer Case	
1985-86	
Selec-Trac (229 Full-Time)	6.0 Pts. (2.8L)
Command-Trac (Part-Time 207)	4.5 Pts. (2.1L)
1987	
Selec-Trac	2.5 Pts. (1.2L)
Command-Trac	2.2 Pts. (1.0L)
1988	
Selec-Trac	3.0 Pts. (1.4L)
Command-Trac	2.2 Pts. (1.0L)
Drive Axles (3)	
Front	2.5 Pts. (1.2L)
Front (Disconnect Housing)	5.0 Ozs. (0.15L)
Rear	2.5 Pts. (1.2L)
Rear (Trac-Lok) (4)	2.5 Pts. (1.2L)

(1) - Capacities are recommended or calculated levels. Always use dipstick (if available) to measure level.
(2) - Includes 2.3 qts. for coolant recovery bottle.
(3) - Fill to bottom of filler plug hole.
(4) - Add 4 ozs. (118 ml) of Limited-Slip differential lubricant additive first, then add new fluid.

105,000 MILE (168,000 KM) SERVICE

105,000 MILE (168,000 KM) SERVICE

	Service Or Inspect
	Verify Last Major Service Was Performed
	Check Fluid Levels
	Check Fuel Lines, Connections
	Check Cooling System Hoses and Clamps
	Check Coolant Strength
	Check Exhaust System & Heat Shielding

	Clean Battery and Battery Terminals
	Inspect Brake System
	Check Operation of Horn, Wipers/Washers & All Exterior Lights
	Inspect Condition of Wiper Blades
	Check Headlight Alignment
	Check Seat Belt Webbing and Release Mechanisms
	Check Parking Brake Operation
	Check Shift/Clutch Interlock Operation
	Inspect C/V Joint boots (4WD)
	Inspect Underside of Vehicle (Bolts & Threaded Fasteners)
	Check/Lube Manual Steering Gear
	Check Drive Shaft Seals
	Lubricate Ball Joints, Steering Linkage & Suspension
	Lube Drive Shaft U-Joints and Slip Splines
	Lube Front Axle Drive Joint and Pivot Bearings (4WD)
	Inspect Front Wheel Bearings (4WD)
	Lubricate Weatherstripping with Silicone
	Lubricate Door Hinges
	Lubricate Door Locks
	Check Body Drain Holes
	Rotate Tires and Adjust Air Pressure
Replace	
	Engine Oil
	Oil Filter
	Flush and Fill Engine Coolant, if not done in last 24 months
Lubrication Specifications	

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Application                                              Specification

Automatic Transmission  .........................  Dexron-IIE ATF
Brake Master Cylinder  ..........  DOT 3 (SAE J-1703F) Brake Fluid
Engine Coolant  ...........  Alugard 340-2 & Water (50/50 Mixture)
Engine Oil (1)
  Gasoline Engine
    Temperature Range
      Above 30° F (-1°C)  ........  SAE 20W-40 Or 20W-50 API SH/CD
      Above 0° F (-18°C) .........  SAE 10W-30 Or 10W-40 API SH/CD
      Less Than 60° F (16°C)  ..............  SAE 5W-30 API SH/CD
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Drive Axles	SAE 75W-90 API GL-5
Drive Axles (Trac-Lok) (2)	SAE 80W-140 API GL-5
Drive Axles (Trailer Towing)	SAE 80W-140 API GL-5
Hydraulic Clutch	DOT 3 (SAE J-1703F) Brake Fluid
Manual Transmission	SAE 75W-90 API GL-5
Parking Brake Cable Guides	NLGI Grade 2, GC-LB
Door & Hood Hinges	Light Engine Oil
Manual Steering Box	Multi-Purpose NLGI Grade 2EP
Power Steering Pump	Power Steering Fluid
Transfer Case	Dexron-IIE ATF
Brake Caliper Bushings	GE 661 or DOW 111 Silicone Grease
Caliper Slide Pins	GE 661 or DOW 111 Silicone Grease
Wheel Bearings	Multi-Purpose NLGI Grade GC-LB
Drive Shaft U-Joints	Multi-Purpose NLGI Grade 2EP
Steering Linkage (4)(5)	NLGI Grade 2, GC-LB
Ball Joints (4)(6)	NLGI Grade 2, GC-LB
Weatherstrip	Silicone Spray Lubricant
Wheel Lug Nut Torque	95 ft. lbs. (129 N.m)

(1) - SAE 10W-30 SH/CD is preferred.
(2) - Add 4 ozs. (118 ml) of Limited-Slip differential lubricant additive when changing fluid.
(3) - For vehicles operating under heavy-duty towing conditions, use SAE 75W-140 Synthetic lube.
NOTE: Before using SAE 75W-140 Synthetic the old fluid must be DRAINED and FLUSHED with clean mineral based axle lubricant. Then refill with new synthetic lube.
(4) - Use low pressure grease gun to prevent seal damage.
(5) - Fill until lubricant squeezes out from the base of seals.
(6) - Fill ball joint until seal starts to swell.

Fluid Capacities

Application	(1) Quantity
Automatic Transmission	
1984-86 (904 HD)	
Fluid Change	4.0 Qts. (3.8L)
Overhaul (Dry Fill)	8.0 Qts. (7.6L)
1987-88	
Fluid Change	4.0 Qts. (3.8L)
Overhaul (Dry Fill)	8.5 Qts. (8.0L)
Cooling System (2)	
4-Cylinder	10.0 Qts. (9.5L)
6-Cylinder	12.0 Qts. (11.4L)
Engine Oil	
4-Cylinder	4.0 Qts. (3.8L)
6-Cylinder	6.0 Qts. (5.7L)
Fuel Tank	
Standard	13.5 Gals. (51.1L)
Optional	20 Gals. (75.7L)
Manual Transmission (3)	
AX4 (AISIN)	7.4 Pts. (3.5L)
T4 (Borg-Warner)	3.9 Pts. (1.8L)
AX5 (AISIN)	7.0 Pts. (3.3L)
T5 (Borg-Warner)	4.5 Pts. (2.1L)
Transfer Case	
1985-86	
Selec-Trac (229 Full-Time)	6.0 Pts. (2.8L)
Command-Trac (Part-Time 207)	4.5 Pts. (2.1L)
1987	
Selec-Trac	2.5 Pts. (1.2L)
Command-Trac	2.2 Pts. (1.0L)

1988	
Selec-Trac	3.0 Pts. (1.4L)
Command-Trac	2.2 Pts. (1.0L)
Drive Axles (3)	
Front	2.5 Pts. (1.2L)
Front (Disconnect Housing)	5.0 Ozs. (0.15L)
Rear	2.5 Pts. (1.2L)
Rear (Trac-Lok) (4)	2.5 Pts. (1.2L)

(1) - Capacities are recommended or calculated levels. Always use dipstick (if available) to measure level.
(2) - Includes 2.3 qts. for coolant recovery bottle.
(3) - Fill to bottom of filler plug hole.
(4) - Add 4 ozs. (118 ml) of Limited-Slip differential lubricant additive first, then add new fluid.

112,500 MILE (180,000 KM) SERVICE

112,500 MILE (180,000 KM) SERVICE

	Service Or Inspect
	Verify Last Major Service Was Performed
	Check Fluid Levels
	Check Cooling System Hoses and Clamps
	Check Coolant Strength
	Clean Battery and Battery Terminals
	Check Exhaust System & Heat Shielding
	Check Operation of Horn, Wipers/Washers & All Exterior Lights
	Inspect Condition of Wiper Blades
	Check Headlight Alignment
	Check Seat Belt Webbing and Release Mechanisms
	Check Parking Brake Operation
	Check Shift/Clutch Interlock Operation
	Inspect C/V Joint boots (4WD)
	Inspect Underside of Vehicle (Bolts & Threaded Fasteners)
	Check/Lube Manual Steering Gear
	Check Drive Shaft Seals
	Lubricate Ball Joints, Steering Linkage & Suspension
	Lube Drive Shaft U-Joints and Slip Splines
	Lube Front Axle Drive Joint and Pivot Bearings (4WD)
	Lube Parking Brake Ratio Lever Pivot

	Lube Manual Gearshift Control (4WD Transfer Case)
	Inspect/Repack Front Wheel Bearings (2WD Models)
	Inspect Front Brake Pads & Rotors
	Lubricate Caliper Slide Rails
	Inspect Rear Brake Linings & Drums
	Inspect Brake System Hoses & Lines
	Inspect Shocks for Leakage
	Inspect Tire Wear Pattern
	Lubricate Weatherstripping with Silicone
	Lubricate Door Hinges
	Lubricate Door Locks
	Check Body Drain Holes
	Rotate Tires and Adjust Air Pressure
Replace	
	Engine Oil
	Oil Filter, if it has not been changed in the last 12 months
	Manual Transmission Fluid
	Automatic Transmission Fluid, Filter and Adjust Bands
	Transfer Case Fluid
	Flush and Fill Engine Coolant, if not done in last 24 months

Lubrication Specifications

Application	Specification
Automatic Transmission	Dexron-IIE ATF
Brake Master Cylinder	DOT 3 (SAE J-1703F) Brake Fluid
Engine Coolant	Alugard 340-2 & Water (50/50 Mixture)
Engine Oil (1)	
Gasoline Engine	
Temperature Range	
Above 30° F (-1°C)	SAE 20W-40 Or 20W-50 API SH/CD
Above 0° F (-18°C)	SAE 10W-30 Or 10W-40 API SH/CD
Less Than 60° F (16°C)	SAE 5W-30 API SH/CD
Drive Axles	SAE 75W-90 API GL-5
Drive Axles (Trac-Lok) (2)	SAE 80W-140 API GL-5
Drive Axles (Trailer Towing)	SAE 80W-140 API GL-5
Hydraulic Clutch	DOT 3 (SAE J-1703F) Brake Fluid
Manual Transmission	SAE 75W-90 API GL-5
Parking Brake Cable Guides	NLGI Grade 2, GC-LB
Door & Hood Hinges	Light Engine Oil
Manual Steering Box	Multi-Purpose NLGI Grade 2EP
Power Steering Pump	Power Steering Fluid

Transfer Case	Dexron-IIE ATF
Brake Caliper Bushings	GE 661 or DOW 111 Silicone Grease
Caliper Slide Pins	GE 661 or DOW 111 Silicone Grease
Wheel Bearings	Multi-Purpose NLGI Grade GC-LB
Drive Shaft U-Joints	Multi-Purpose NLGI Grade 2EP
Steering Linkage (4)(5)	NLGI Grade 2, GC-LB
Ball Joints (4)(6)	NLGI Grade 2, GC-LB
Weatherstrip	Silicone Spray Lubricant
Wheel Lug Nut Torque	95 ft. lbs. (129 N.m)

(1) - SAE 10W-30 SH/CD is preferred.
(2) - Add 4 ozs. (118 ml) of Limited-Slip differential lubricant additive when changing fluid.
(3) - For vehicles operating under heavy-duty towing conditions, use SAE 75W-140 Synthetic lube.
NOTE: Before using SAE 75W-140 Synthetic the old fluid must be DRAINED and FLUSHED with clean mineral based axle lubricant. Then refill with new synthetic lube.
(4) - Use low pressure grease gun to prevent seal damage.
(5) - Fill until lubricant squeezes out from the base of seals.
(6) - Fill ball joint until seal starts to swell.

Fluid Capacities

Application	(1) Quantity
Automatic Transmission	
1984-86 (904 HD)	
Fluid Change	4.0 Qts. (3.8L)
Overhaul (Dry Fill)	8.0 Qts. (7.6L)
1987-88	
Fluid Change	4.0 Qts. (3.8L)
Overhaul (Dry Fill)	8.5 Qts. (8.0L)
Cooling System (2)	
4-Cylinder	10.0 Qts. (9.5L)
6-Cylinder	12.0 Qts. (11.4L)
Engine Oil	
4-Cylinder	4.0 Qts. (3.8L)
6-Cylinder	6.0 Qts. (5.7L)
Fuel Tank	
Standard	13.5 Gals. (51.1L)
Optional	20 Gals. (75.7L)
Manual Transmission (3)	
AX4 (AISIN)	7.4 Pts. (3.5L)
T4 (Borg-Warner)	3.9 Pts. (1.8L)
AX5 (AISIN)	7.0 Pts. (3.3L)
T5 (Borg-Warner)	4.5 Pts. (2.1L)
Transfer Case	
1985-86	
Selec-Trac (229 Full-Time)	6.0 Pts. (2.8L)
Command-Trac (Part-Time 207)	4.5 Pts. (2.1L)
1987	
Selec-Trac	2.5 Pts. (1.2L)
Command-Trac	2.2 Pts. (1.0L)
1988	
Selec-Trac	3.0 Pts. (1.4L)
Command-Trac	2.2 Pts. (1.0L)
Drive Axles (3)	
Front	2.5 Pts. (1.2L)
Front (Disconnect Housing)	5.0 Ozs. (0.15L)
Rear	2.5 Pts. (1.2L)
Rear (Trac-Lok) (4)	2.5 Pts. (1.2L)

(1) - Capacities are recommended or calculated levels. Always use dipstick (if available) to measure level.
(2) - Includes 2.3 qts. for coolant recovery bottle.
(3) - Fill to bottom of filler plug hole.
(4) - Add 4 ozs. (118 ml) of Limited-Slip differential lubricant additive first, then add new fluid.

120,000 MILE (192,000 KM) SERVICE

120,000 MILE (192,000 KM) SERVICE

	Service Or Inspect
	Verify Last Major Service Was Performed
	Check Fluid Levels
	Check Cooling System Hoses and Clamps
	Check Coolant Strength
	Check Accessory Drive Belts
	Check Exhaust System & Heat Shielding
	Clean Battery and Battery Terminals
	Adjust Drive Belt Tension
	Accessory Drive Belts
	Adjust Idle - Propane Method (1987-88)
	Ignition Timing
	Lubricate Manifold Heat Control Valve (3.9L & 5.2L Engines)
	Clean PCV Breather (3.9L & 5.2L Engines)
	Clean EGR Passages (if equipped)
	Inspect C/V Joint boots (4WD)
	Inspect Underside of Vehicle (Bolts & Threaded Fasteners)
	Check/Lube Manual Steering Gear
	Check Drive Shaft Seals
	Lubricate Ball Joints, Steering Linkage & Suspension
	Lube Drive Shaft U-Joints and Slip Splines
	Lube Front Axle Drive Joint and Pivot Bearings (4WD)
	Inspect Front Wheel Bearings (4WD)
	Clean and Lubricate Crankcase Inlet Air Cleaner
	Suspension Bushings, Springs, Arms & Rear Jounce Bumpers

	Parking Brake System
	Inspect Shocks for Leakage
	Inspect Tire Wear Pattern
	Rotate Tires and Adjust Air Pressure (Including Spare)
Replace	
	Engine Oil
	Oil Filter
	Spark Plugs
	Ignition Cables
	Distributor Cap and Rotor
	Air Filter Element
	Fuel Filter
	PCV Valve (1)
	PCV Filter
	EGR Valve & Tube (1987-92)
	Vacuum Operated Emission Components (1987-92)
	PCV Valve (1)
	Drive Belt (V-Type) (2)
	Flush and Fill Engine Coolant, if not done in last 24 months
	Automatic Transmission Fluid, Filter and Adjust Bands

(1) - Replacement is recommended by Chrysler at this time, but it is not required to maintain the warranty on the PCV valve.
(2) - Check and replace as needed.

Lubrication Specifications

Application	Specification
Automatic Transmission	Dexron-IIE ATF
Brake Master Cylinder	DOT 3 (SAE J-1703F) Brake Fluid
Engine Coolant	Alugard 340-2 & Water (50/50 Mixture)
Engine Oil (1)	
Gasoline Engine	
Temperature Range	
Above 30° F (-1°C)	SAE 20W-40 Or 20W-50 API SH/CD
Above 0° F (-18°C)	SAE 10W-30 Or 10W-40 API SH/CD
Less Than 60° F (16°C)	SAE 5W-30 API SH/CD
Drive Axles	SAE 75W-90 API GL-5
Drive Axles (Trac-Lok) (2)	SAE 80W-140 API GL-5
Drive Axles (Trailer Towing)	SAE 80W-140 API GL-5
Hydraulic Clutch	DOT 3 (SAE J-1703F) Brake Fluid
Manual Transmission	SAE 75W-90 API GL-5
Parking Brake Cable Guides	NLGI Grade 2, GC-LB

Door & Hood Hinges	Light Engine Oil
Manual Steering Box	Multi-Purpose NLGI Grade 2EP
Power Steering Pump	Power Steering Fluid
Transfer Case	Dexron-IIE ATF
Brake Caliper Bushings	GE 661 or DOW 111 Silicone Grease
Caliper Slide Pins	GE 661 or DOW 111 Silicone Grease
Wheel Bearings	Multi-Purpose NLGI Grade GC-LB
Drive Shaft U-Joints	Multi-Purpose NLGI Grade 2EP
Steering Linkage (4)(5)	NLGI Grade 2, GC-LB
Ball Joints (4)(6)	NLGI Grade 2, GC-LB
Weatherstrip	Silicone Spray Lubricant
Wheel Lug Nut Torque	95 ft. lbs. (129 N.m)

(1) - SAE 10W-30 SH/CD is preferred.
(2) - Add 4 ozs. (118 ml) of Limited-Slip differential lubricant additive when changing fluid.
(3) - For vehicles operating under heavy-duty towing conditions, use SAE 75W-140 Synthetic lube.
NOTE: Before using SAE 75W-140 Synthetic the old fluid must be DRAINED and FLUSHED with clean mineral based axle lubricant. Then refill with new synthetic lube.
(4) - Use low pressure grease gun to prevent seal damage.
(5) - Fill until lubricant squeezes out from the base of seals.
(6) - Fill ball joint until seal starts to swell.

Fluid Capacities

Application	(1) Quantity
Automatic Transmission	
1984-86 (904 HD)	
Fluid Change	4.0 Qts. (3.8L)
Overhaul (Dry Fill)	8.0 Qts. (7.6L)
1987-88	
Fluid Change	4.0 Qts. (3.8L)
Overhaul (Dry Fill)	8.5 Qts. (8.0L)
Cooling System (2)	
4-Cylinder	10.0 Qts. (9.5L)
6-Cylinder	12.0 Qts. (11.4L)
Engine Oil	
4-Cylinder	4.0 Qts. (3.8L)
6-Cylinder	6.0 Qts. (5.7L)
Fuel Tank	
Standard	13.5 Gals. (51.1L)
Optional	20 Gals. (75.7L)
Manual Transmission (3)	
AX4 (AISIN)	7.4 Pts. (3.5L)
T4 (Borg-Warner)	3.9 Pts. (1.8L)
AX5 (AISIN)	7.0 Pts. (3.3L)
T5 (Borg-Warner)	4.5 Pts. (2.1L)
Transfer Case	
1985-86	
Selec-Trac (229 Full-Time)	6.0 Pts. (2.8L)
Command-Trac (Part-Time 207)	4.5 Pts. (2.1L)
1987	
Selec-Trac	2.5 Pts. (1.2L)
Command-Trac	2.2 Pts. (1.0L)
1988	
Selec-Trac	3.0 Pts. (1.4L)
Command-Trac	2.2 Pts. (1.0L)
Drive Axles (3)	
Front	2.5 Pts. (1.2L)
Front (Disconnect Housing)	5.0 Ozs. (0.15L)

Rear	2.5 Pts. (1.2L)
Rear (Trac-Lok) (4)	2.5 Pts. (1.2L)

(1) - Capacities are recommended or calculated levels. Always use dipstick (if available) to measure level.
(2) - Includes 2.3 qts. for coolant recovery bottle.
(3) - Fill to bottom of filler plug hole.
(4) - Add 4 ozs. (118 ml) of Limited-Slip differential lubricant additive first, then add new fluid.

Service Labor Times

Application	Hours
2.5L	
Automatic Transmission	3.5
Manual Transmission	3.5
2.8L	
Automatic Transmission	3.7
Manual Transmission	3.7
4.0L	
Automatic Transmission	3.6
Manual Transmission	3.6

LUBRICATION SPECIFICATIONS

LUBRICATION SPECIFICATIONS TABLE

Application	Fluid Specifications
Automatic Transmission	Dexron-IIE ATF
Brake Master Cylinder	DOT 3 (SAE J-1703F) Brake Fluid
Engine Coolant	Alugard 340-2 & Water (50/50 Mixture)
Engine Oil (1)	
Gasoline Engine	
Temperature Range	
Above 30° F (-1°C)	SAE 20W-40 Or 20W-50 API SH/CD
Above 0° F (-18°C)	SAE 10W-30 Or 10W-40 API SH/CD
Less Than 60° F (16°C)	SAE 5W-30 API SH/CD
Drive Axles	SAE 75W-90 API GL-5
Drive Axles (Trac-Lok) (2)	SAE 80W-140 API GL-5
Drive Axles (Trailer Towing)	SAE 80W-140 API GL-5
Hydraulic Clutch	DOT 3 (SAE J-1703F) Brake Fluid
Manual Transmission	SAE 75W-90 API GL-5
Manual Steering Box	Multi-Purpose NLGI Grade 2EP
Power Steering Pump	Power Steering Fluid
Transfer Case	Dexron-IIE ATF
Brake Caliper Bushings	GE 661 or DOW 111 Silicone Grease
Caliper Slide Pins	GE 661 or DOW 111 Silicone Grease
Wheel Bearings	Mopar Multi-Purpose NLGI Grade GC-LB
Drive Shaft U-Joints	Mopar Multi-Purpose NLGI Grade 2EP
Steering Linkage (4)(5)	Mopar Multi-mileage or equivalent
Ball Joints (4)(6)	Mopar Multi-mileage or equivalent
Weatherstrip	Silicone Spray Lubricant

(1) - SAE 10W-30 SH/CD is preferred.
(2) - Add 4 ozs. (118 ml) of Limited-Slip differential lubricant additive when changing fluid.
(3) - For vehicles operating under heavy-duty towing conditions, use SAE 75W-140 Synthetic lube.
NOTE: Before using SAE 75W-140 Synthetic the old fluid must be

DRAINED and FLUSHED with clean mineral based (non-synthetic) axle lubricant. Then refill with new synthetic lube.
(4) - Use low pressure grease gun to prevent seal damage.
(5) - Fill until lubricant squeezes out from the base of seals.
(6) - Fill ball joint until seal starts to swell.

FLUID CAPACITIES

FLUID CAPACITIES TABLE

Application	Quantity (1)
A/C System R-12 Refrigerant Capacity	36-40 Ozs.
Automatic Transmission	
1984-86 (904 HD)	
Fluid Change	4.0 Qts. (3.8L)
Overhaul (Dry Fill)	8.0 Qts. (7.6L)
1987-88	
Fluid Change	4.0 Qts. (3.8L)
Overhaul (Dry Fill)	8.5 Qts. (8.0L)
Cooling System (2)	
4-Cylinder	10.0 Qts. (9.5L)
6-Cylinder	12.0 Qts. (11.4L)
Engine Oil	
4-Cylinder	4.0 Qts. (3.8L)
6-Cylinder	6.0 Qts. (5.7L)
Fuel Tank	
Standard	13.5 Gals. (51.1L)
Optional	20 Gals. (75.7L)
Manual Transmission (3)	
AX4 (AISIN)	7.4 Pts. (3.5L)
T4 (Borg-Warner)	3.9 Pts. (1.8L)
AX5 (AISIN)	7.0 Pts. (3.3L)
T5 (Borg-Warner)	4.5 Pts. (2.1L)
Transfer Case	
1985-86	
Selec-Trac (229 Full-Time)	6.0 Pts. (2.8L)
Command-Trac (Part-Time 207)	4.5 Pts. (2.1L)
1987	
Selec-Trac	2.5 Pts. (1.2L)
Command-Trac	2.2 Pts. (1.0L)
1988	
Selec-Trac	3.0 Pts. (1.4L)
Command-Trac	2.2 Pts. (1.0L)
Drive Axles (3)	
Front	2.5 Pts. (1.2L)
Front (Disconnect Housing)	5.0 Ozs. (0.15L)
Rear	2.5 Pts. (1.2L)
Rear (Trac-Lok) (4)	2.5 Pts. (1.2L)

(1) - Capacities are recommended or calculated levels. Always use dipstick (if available) to measure level.
(2) - Includes 2.3 qts. for coolant recovery bottle.
(3) - Fill to bottom of filler plug hole.
(4) - Add 4 ozs. (118 ml) of Limited-Slip differential lubricant additive first, then add new fluid.

1988 Power Seats
JEEP

Cherokee, Wagoneer,
Grand Wagoneer

DESCRIPTION

A 3 armature permanent magnet reversible motor is coupled through cables to rack and pinion assemblies, located in the tracks. This system provides 6 different movement directions. Circuit is protected by a 30-amp circuit breaker on the fuse block.

TESTING

PRELIMINARY CHECKS

Ensure battery is fully charged and all electrical connections are clean and tight. Turn on dome light. Apply switch to the inoperative position. If dome light dims, seat motion is attempting to function, indicating mechanical failure. Check and repair as necessary. If dome light does not dim, proceed with the following tests.

HARNESS VOLTAGE

Disconnect switch harness connector, located under seat. Connect ground lead of test light to terminal No. 2. Touch other lead of test light to terminal No. 1. See Fig. 1. If test light comes on, circuit is good. If test light does not come on, check circuit breaker and harness. If harness and circuit breaker checks good, perform drive motors check.

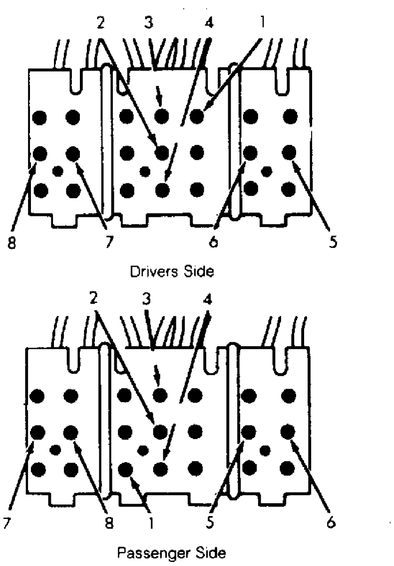


Fig. 1: Seat Switch Terminal Identification
Courtesy of Chrysler Motors.

DRIVE MOTORS

Rear Motor

Disconnect switch harness connector. Connect a covered jumper wire between terminal No. 1 and 5. See Fig. 1. Connect a second covered jumper wire between terminal No. 2 and 6. If motor does not operate, reverse jumper wire at terminal No. 5 and 6. If motor still does not operate, either harness or complete 3 motor assembly is defective.

Center Motor

Disconnect switch harness connector. Connect a covered jumper wire between terminal No. 1 and 3. See Fig. 1. Connect a second covered jumper wire between terminal No. 2 and 4. If motor does not operate, reverse jumper wire at terminal No. 3 and 4. If motor still does not operate, either harness or complete 3 motor assembly is defective.

Front Motor

Disconnect switch harness connector. Connect a covered jumper wire between terminal No. 1 and 7. See Fig. 1. Connect a second covered jumper wire between terminal No. 2 and 8. If motor does not operate, reverse jumper wire at terminal No. 7 and 8. If motor still does not operate, either harness or complete 3 motor assembly is defective.

NOTE: No further testing information is available from manufacturer.

REMOVAL & INSTALLATION

MOTOR

CAUTION: Use care to avoid bending drive cables during removal.

NOTE: Whenever maintenance of motor, cable and housing assemblies or transmissions is necessary, they must be synchronized to ensure easy and proper operation. Refer to manufacturer for proper procedure.

Removal & Installation

Remove seat assembly. Lay seat assembly on its back. Remove motor mounting screws. Disconnect housings and cables from motor assembly and remove motor. To install, reverse removal procedure.

SERVICE INDICATOR & WARNING LIGHTS

1988 Jeep Cherokee

1984-92 MAINTENANCE
AMC/Jeep/Eagle Service Indicator & Warning Lights

Jeep; Cherokee, Wagoneer

SERVICE INDICATOR & WARNING LIGHTS

BRAKE WARNING LIGHT

If the light stays on when the parking brake is off, it indicates a possible brake system fluid leak or low pressure level.

LOCK INDICATOR LIGHT (1984-87)

Indicates that Selec-Trac transfer case is in part time 4WD (high or low range).

FULL TIME 4WD INDICATOR LIGHT

Indicates that Selec-Trac transfer case is in full-time 4WD (4x4 FULL TIME).

PART TIME 4WD INDICATOR LIGHT

Indicates that Selec-Trac transfer case is in part time 4WD (4x4 PART TIME or 4 LO) or that Command-Trac transfer case is in 4WD (4H or 4L).

WATER IN FUEL LIGHT (TURBO DIESEL)

Indicates water has collected in the fuel filter and should be drained immediately.

DIESEL WAIT LIGHT (TURBO DIESEL)

Illuminates during glow plugs warm-up cycle.

LOW FUEL WARNING LIGHT

Glows when approximately 2 gals. (7.6L) remain in fuel tank.

EMISSION MAINTENANCE INDICATOR LIGHT

Illuminates at approximately 82,500 miles to indicate scheduled maintenance (or recommended maintenance on California vehicles). Light will remain on until system is serviced and light is reset.

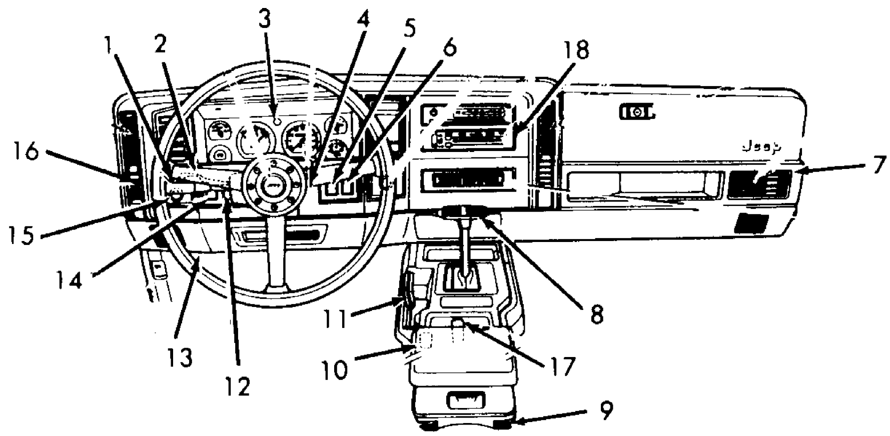
CHECK ENGINE LIGHT

If this light illuminates and remains on while driving, it indicates a potential engine control problem that needs service.

CHECK ANTI-LOCK LIGHT

Illuminates to indicate a self-check is in process at vehicle start up. If light remains on after start-up or comes on and stays on

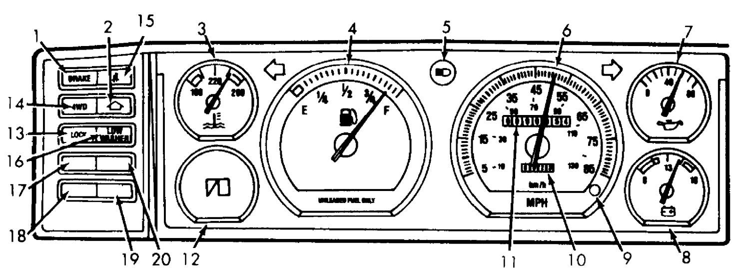
at road speeds, it may indicate that the ABS system has detected a malfunction or has become inoperative. The system reverts to standard non-anit-lock brakes. If both Red BRAKE light and Amber CHECK ANTI-LOCK light are on, have vehicle serviced immediately.



1. Multifunction Stalk: Turn Signals, Wiper/Washer, High Beam, Cruise Control
2. Tilt Steering Column Control
3. Instrument Cluster
4. Hazard Warning Flasher Switch
5. Automatic Transmission Mode Selection Switch
6. Rear Window Wiper/Washer Control
7. Side Window Defogger
8. Gear Shift Lever
9. Rear Seat Heater Outlet
10. Power Remote Outside Mirror Control
11. Transfer Case Shift Lever
12. Rear Window Defogger/Defroster Switch
13. Fuse Panel
14. Fog Lamp Switch
15. Headlight Switch
16. Side Window Defogger
17. Parking Brake
18. Climate Controls

90C06574

Fig. 1: Instrument Panel Interior Controls
Courtesy of Chrysler Motors.



1. BRAKE & Brake Fluid Pressure Warning Light
2. Upshift Indicator Light (1984-90)
   Part Time 4WD Indicator Light (1991-92)
3. Engine Coolant Temperature Gauge/Warning Light
4. Fuel Gauge
5. Headlights High Beam Indicator
6. Speedometer
7. Oil Pressure Gauge/Warning Light
8. Alternator Warning Light/Voltmeter
9. Trip Odometer Reset Knob
10. Trip Odometer
11. Speedometer
12. Low Fuel Warning Light
13. Lock Indicator Light (1984-90)
    Emission Maintenance Indicator Light (1991-92)
14. Full Time 4WD Indicator Light
15. Security (1991-92)
16. Seat Belt Warning Light (1991-92)
17. CHECK ENGINE Warning Light (1991-92)
18. Upshift Indicator Light (1991-92)
19. CHECK ANTI-LOCK (1991-92)
20. Low Windshield Washer Fluid
    Warning Light

90506577

Fig. 2: Dash Gauges & Warning Lights (Gasoline Engines)
Courtesy of Chrysler Motors.

1. Turbo Boost
2. Water in Fuel
3. Diesel Wait
4. Alternator Warning Light
5. Engine Oil Pressure Gauge

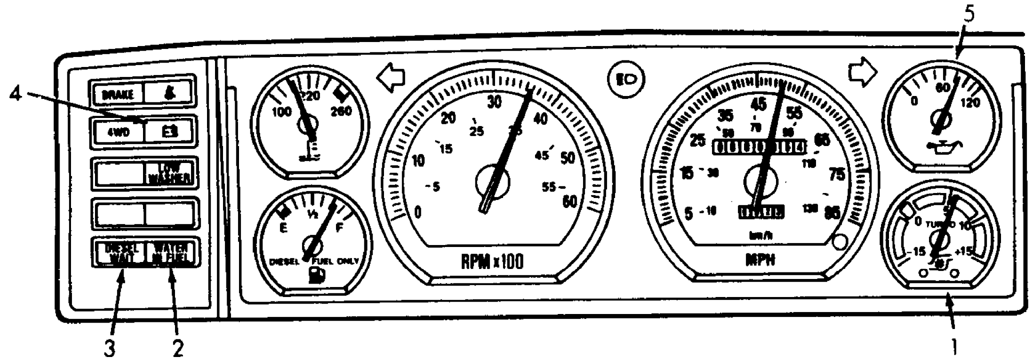


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Fig. 3: Dash Gauges & Warning Lights (Turbo-Diesel Engines)
Courtesy of Chrysler Motors.

97I002000: SHIFT INTERLOCK

1988 Jeep Cherokee

NHTSA RECALL BULLETIN

Model(s):	1984-95 Jeep Cherokee 1993-95 Jeep Grand Cherokee
Campaign No:	97I002000
Number of Affected Vehicles:	2200000
Beginning Date of Manufacture:	1983 AUG
Ending Date of Manufacture:	1995 JUL

VEHICLE DESCRIPTION:

Multipurpose passenger vehicles equipped with automatic transmissions.

DESCRIPTION OF DEFECT:

This is not a safety recall in accordance with Federal Regulation 573. However, it is deemed a safety improvement campaign by the agency.

Drivers can mistakenly step on the accelerator pedal when they intend to step on the brake pedal.

CONSEQUENCE OF DEFECT:

Pedal misapplication by a driver can cause unintended acceleration.

CORRECTIVE ACTION

Dealers will install a shift interlock on the automatic transmission of these vehicles.

Chrysler has decided to conduct a safety improvement campaign to install a shift interlock on these vehicles. Owners can contact Chrysler at 1-800-853-1403.

ADDITIONAL INFORMATION:

The National Highway Traffic Safety Administration operates Monday through Friday from 8:00 AM to 4:00 PM, Eastern Time. For more information call (800) 424-9393 or (202) 366-0123. For the hearing impaired, call (800) 424-9153.

SPARK CONTROL SYSTEM

1988 Jeep Cherokee

1988 Exhaust Emission Systems
JEEP SPARK CONTROL SYSTEMS

DESCRIPTION

Jeep vehicles use spark control devices to assist ignition system in controlling exhaust emissions. They are Spark Control Temperature Override (CTO) valve, Non-Linear Vacuum Regulator (NLVR) valve, Forward Delay Valve, Reverse Delay Valve and on 4-cylinder engines, Vacuum Spark Control Delay Valve. System application depends upon engine size, emissions category and vehicle model.

COOLANT TEMPERATURE SENSOR (CTS)

The coolant temperature sensor is located in the intake manifold coolant jacket. This sensor provides a voltage signal to the Electronic Control Unit (ECU). The ECU uses this signal to determine engine temperature. During cold engine operation, the ECU responds by increasing ignition advance and inhibiting EGR operation.

NON-LINEAR VACUUM REGULATOR VALVE (NLVR)

NLVR valve is used on carbureted 6.0L models. This valve supplies vacuum advance unit with a regulated combination of manifold and carburetor ported vacuum when engine load is low and switches to supply only carburetor ported vacuum as load increases.

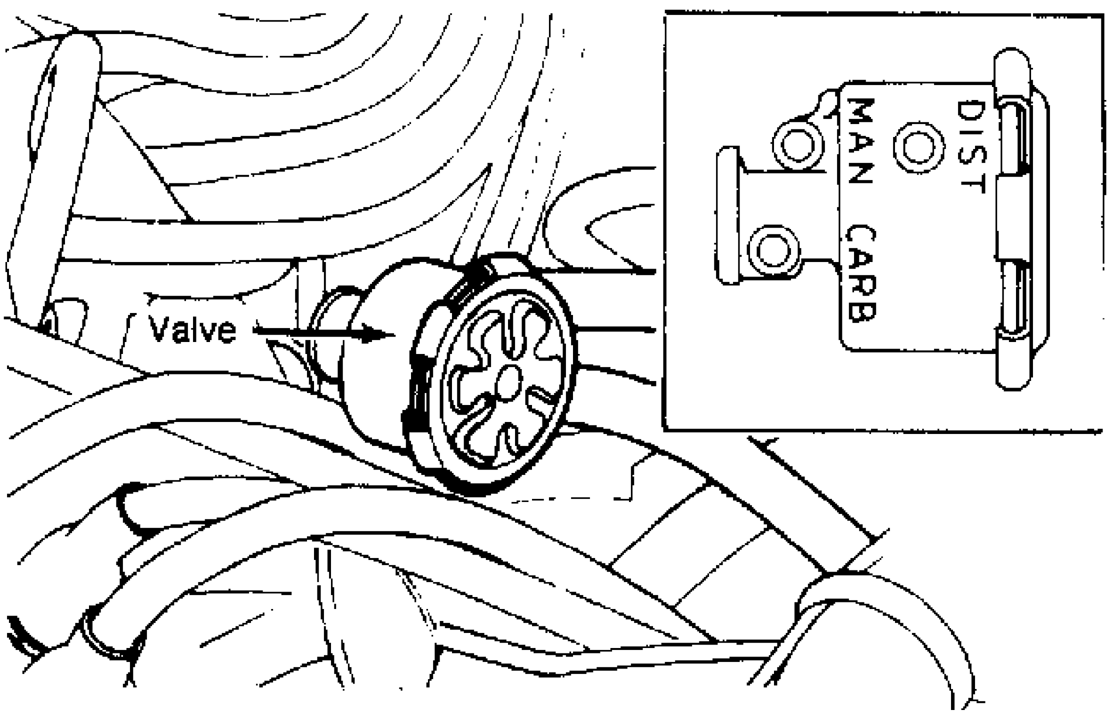


Fig. 1: Non-Linear Vacuum Regulator Valve
Courtesy of Chrysler Motors.

OPERATION

NON-LINEAR VACUUM REGULATOR VALVE

There are 2 input ports on NLVR: intake manifold vacuum and carburetor ported vacuum. One outlet port connects to distributor vacuum unit. At curb idle, regulated vacuum is supplied to advance unit, when manifold vacuum is high and ported vacuum is very low. See Fig. 1.

NLVR regulates vacuum signal so it is between these 2 vacuum source levels at idle. As engine load increases and vacuum signal is above 7.5 in. Hg vacuum, regulator valve switches to ported vacuum output.

FORWARD DELAY VALVE

Some engines use this valve to improve driveability and reduce hydrocarbon emissions. Valve functions to delay effects of sudden increases in vacuum. This prevents sudden spark advance during deceleration.

REVERSE DELAY VALVE

Some engines use this valve to improve cold driveability and reduce hydrocarbon emissions. Valve is installed in vacuum line to delay effects of manifold vacuum decrease causing retarded ignition timing.

VACUUM ADVANCE COOLANT TEMPERATURE OVERRIDE (VA-CTO)

This valve is used on carbureted 6.0L engines to improve driveability when engine is cold. It is located in vacuum advance circuit. When vacuum is greater at port "4" than at port "1", air must flow through orifice to equalize pressure. This creates momentary delay that prevents sudden decrease in spark advance. When vacuum is greater at port "1" than at port "4", air flows freely through check valve and pressure is instantly equalized.

TESTING

NON-LINEAR VACUUM REGULATOR VALVE (NLVR)

Connect vacuum gauge to distributor port "DIST" on NLVR. With engine at idle speed, a vacuum reading of 7 in. Hg vacuum should be shown. As throttle is opened and engine speed increases, ported vacuum level should be indicated. If not, replace NLVR. See Fig. 1.

FORWARD DELAY VALVE

1) Connect external vacuum source to port on Black (or Red) side of delay valve. Connect vacuum gauge to port on colored side of valve.

2) Apply a constant 10 in. Hg vacuum. Note time required for gauge pointer to move from 0-8 in. Hg.

3) If valve fails to meet time limits, replace valve. If valve meets specifications, install so that Black (or Red) side is toward vacuum source.

FORWARD DELAY VALVE TIME LIMITS (1)

Valve Color	Min. Time	Max Time

Black/Purple	3.2	4.8
Black/Gray	8	12
Black/Brown	16	24
Black/Orange	1.5	2.5
Black/White	50	77
Black/Yellow	80	120
Black/Green	160	240

(1) - Time in seconds.

REVERSE DELAY VALVE

1) Connect external vacuum source to port on White side of delay valve. Connect vacuum gauge to port on colored (non-White) side of valve.

2) Apply a constant 10 in. Hg vacuum, note time required for gauge pointer to move from 0-8 in. Hg.

3) If valve fails to meet time limits, replace valve. If valve meets specifications, install with non-White side toward vacuum source.

REVERSE DELAY VALVE TIME LIMITS (1)

Valve Color	Min. Time	Max. Time
White/Purple	3.2	4.8
White/Gray	8	12
White/Gold	12	18
White/Brown	16	24
White/Yellow	80	120
White/Red	300	450
White/Orange	1.5	2.5

(1) - Time in seconds.

VACUUM SPARK CONTROL DELAY VALVE

1) Connect "T" fitting at ports "1" and "4". Connect vacuum gauge to each fitting. Start engine. Vacuum should be equal at both ports. See Fig. 2.

2) When throttle is suddenly depressed, vacuum at port "1" will instantly decrease and vacuum at port "4" should be maintained momentarily. If valve fails these tests, replace valve.

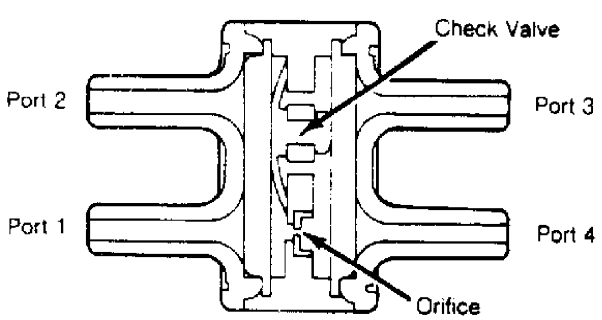


Fig. 2: Vacuum Spark Control Delay Valve
Courtesy of Chrysler Motors.

STARTER - BOSCH/MITSUBISHI

1988 Jeep Cherokee

1988 Starters
BOSCH & MITSUBISHI

Jeep with 4.0L 6-Cyl.

DESCRIPTION

NOTE: Information on Jeep 2.5L starter not available from manufacturer.

Bosch and Mitsubishi use a permanent magnet starter. A planetary gear train transmits power between starter motor and pinion shaft. The starter magnetic field is produced by 6 permanent magnets. The Mitsubishi starter is a 12-volt unit that has the solenoid mounted on the starter housing. See Fig. 3.

TROUBLE SHOOTING

NOTE: See the TROUBLE SHOOTING - BASIC PROCEDURES article in the GENERAL TROUBLE SHOOTING section.

TESTING (ON VEHICLE)

AMPERAGE DRAW TEST

NOTE: Engine should be at operating temperature before performing this test. Heavy duty oil or a tight engine will increase starter draw amperage. Tests are performed with standard volt-ammeter tester.

1) Connect tester and remote starter switch. Set voltmeter selector to 16-volt position. Select function to 0-500-amp scale. Connect voltmeter leads to corresponding polarity battery terminals.

2) Connect ammeter leads to corresponding battery terminals. Disconnect coil wire from distributor cap and attach to ground to prevent engine from starting.

3) Crank engine and observe exact reading on voltmeter. Stop cranking engine. Turn tester control knob clockwise until voltmeter reads exactly the same as when engine was cranked with remote starter switch. Ammeter should indicate starter draw of about 150-220 amps.

STARTER RESISTANCE TEST

Use a voltmeter that will indicate tenths of a volt. Without disconnecting any starter connections, perform the following resistance tests:

1) Perform following tests with engine cranking and all terminals connected. Connect a voltmeter at following locations:

* Positive lead to battery positive post and negative lead to battery terminal on starter.
* Positive lead to starter housing and negative lead to negative post on battery.
* Positive lead to battery negative post and negative lead to battery cable connector on engine block.

2) Each of these 3 connections should show a voltmeter

reading of .2 volt or less. If reading exceeds .2 volt, clean or repair cables and connections in circuit. Connect a voltmeter at following locations:

* Positive lead to battery positive post and negative lead to cable clamp.
* Positive lead to battery negative post and negative lead to cable clamp.

3) If reading is other than zero on voltmeter, clean or repair cables and connections in circuit. Connect a voltmeter at following location:

* Positive lead to battery positive post and negative lead to starter solenoid lead to the field coils.

4) If reading exceeds .3 volt, clean or repair cables and connections in circuit.

SOLENOID TEST

1) Connect a heavy jumper wire on starter relay between battery and solenoid terminals. If engine cranks, solenoid is okay. Go to RELAY TEST.

2) If engine does not crank, check wiring and connections from relay to starter. Repair or replace as necessary. If engine still fails to crank, starter is defective.

RELAY TEST

1) On automatic transmission/transaxle vehicles, put gear selector in "NEUTRAL" or "PARK". On manual transmission/transaxle vehicles, put gear selector in "NEUTRAL". Set parking brake and block wheels. DO NOT remove relay connector. Using a 12-volt test light, check for battery voltage between starter relay battery terminal and ground.

2) Use a jumper wire on starter relay between battery and ignition terminals. If engine cranks starter relay is good. If starter does not crank go to next step.

3) Connect another jumper wire to starter relay between ground terminal and ground. Repeat above test. If engine cranks, starter relay is good. Inspect transmission linkage for improper adjustment (automatic transmission), defective neutral safety switch (automatic transmission) or poor ground connection between relay housing and mounting surface.

TESTING (ON BENCH)

STARTER SOLENOID

1) With starter removed, disconnect field coil wire from field coil terminal on starter. Using an ohmmeter, check for continuity between solenoid and field coil terminals.

2) Check for continuity between solenoid terminal solenoid housing. Continuity should be present in both tests. If continuity is present, solenoid is good. If no continuity is present, replace solenoid. Reconnect field coil wire to field coil terminal.

ARMATURE FOR SHORT CIRCUIT

Place armature in a growler and hold a thin steel blade parallel 3/16" above core while rotating armature slowly. If armature

is shorted, blade will vibrate and be attracted to core. Replace shorted armature.

ARMATURE FOR GROUND

Using a self-powered test light and touch one lead to armature shaft and other lead to each commutator bar. See Fig. 1. If light glows, armature is grounded and should be replaced.

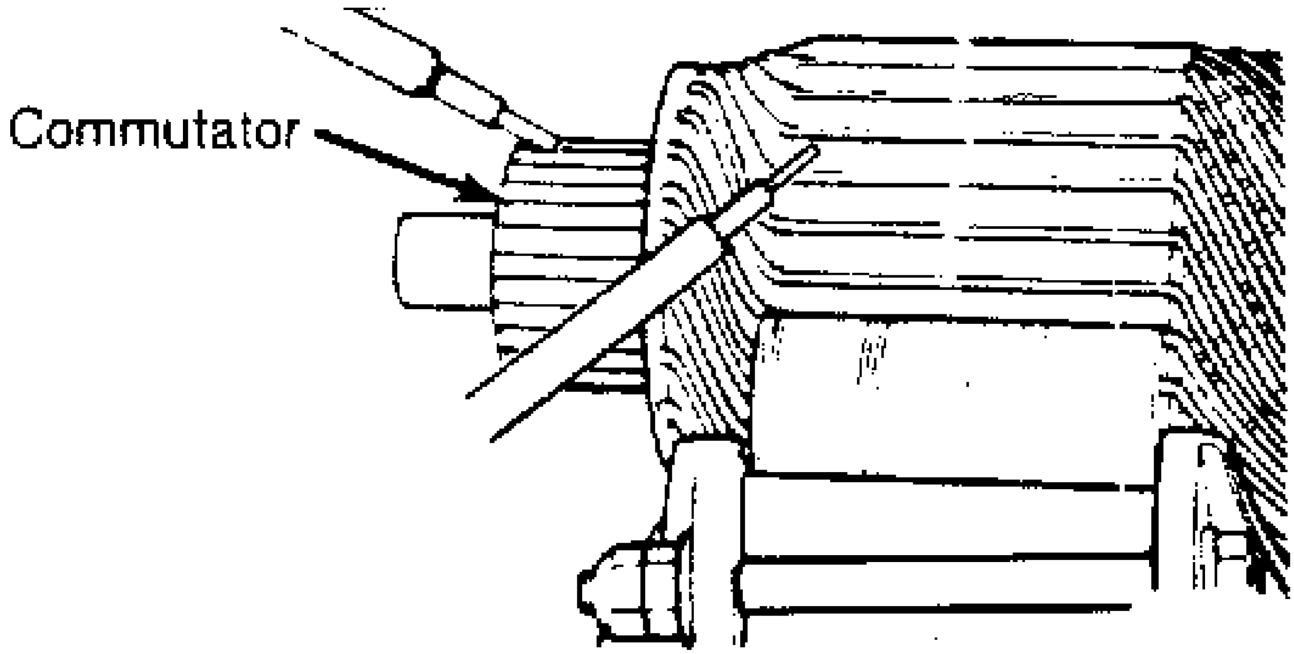


Fig. 1: Testing Starter Armature for Ground

FIELD COILS FOR GROUND

Using a self-powered test light and touch one probe to series field coil lead and other probe to field frame. If light glows, replace field coil housing assembly.

DRIVE CLUTCH UNIT

While holding clutch housing, rotate pinion. Drive pinion should rotate smoothly in one direction only (should not rotate in opposite direction). If drive unit does not operate properly, or if pinion is worn or burred, replace drive unit.

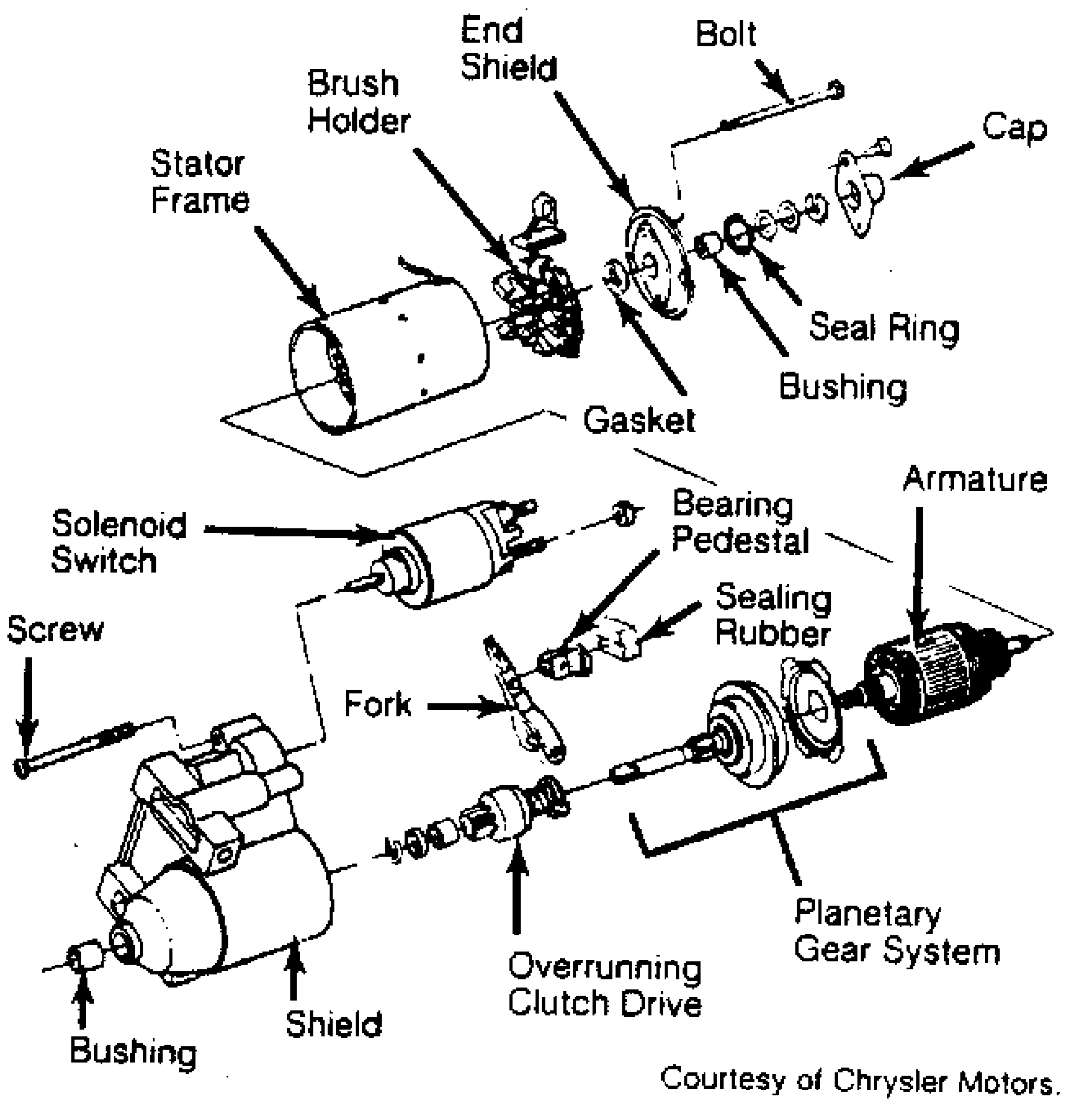


Fig. 2: Exploded View of Bosch Starter

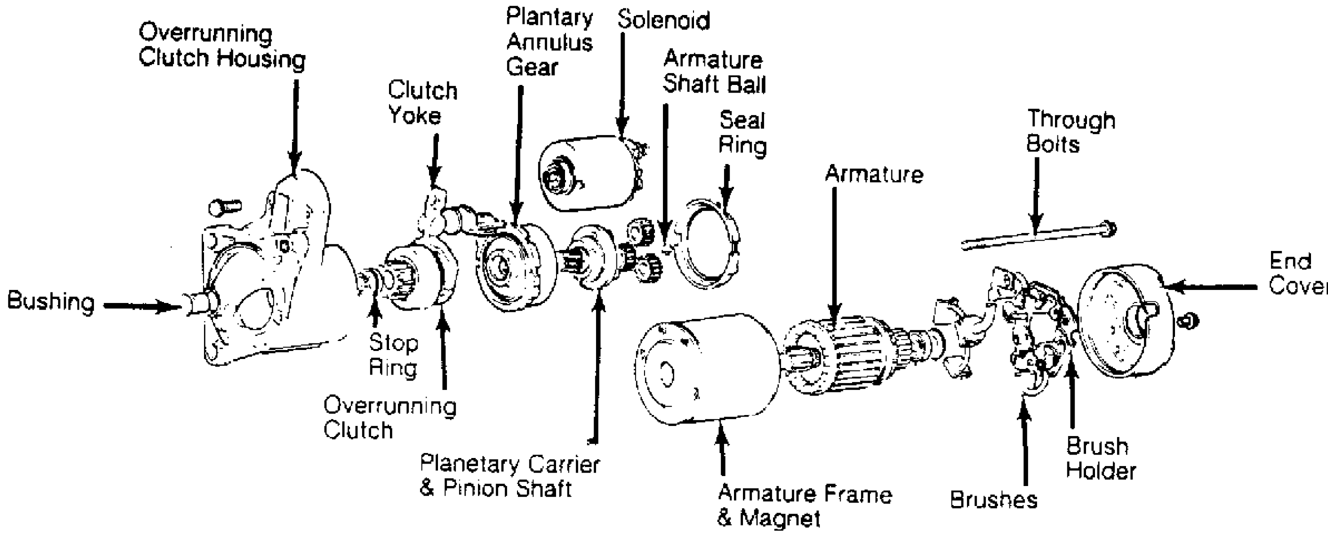


Fig. 3: Exploded View of Mitsubishi Starter

OVERHAUL

Overhaul information not available.

SPECIFICATIONS

BOSCH & MITSUBISHI STARTER SPECIFICATIONS

Application (1)	Specification
Cranking Amperage Draw	120-220 Amps
No Load Test Voltage	11-11.5 Volts
No Load Test Amperage Draw	75-85 Amps
No Load Test Minimum RPM	2500-3625
Solenoid Closing Voltage (All)	7.3-7.8 Volts

(1) - New brushes are 11/16" (17.5 mm) long.

STARTER - PARIS-RHONE

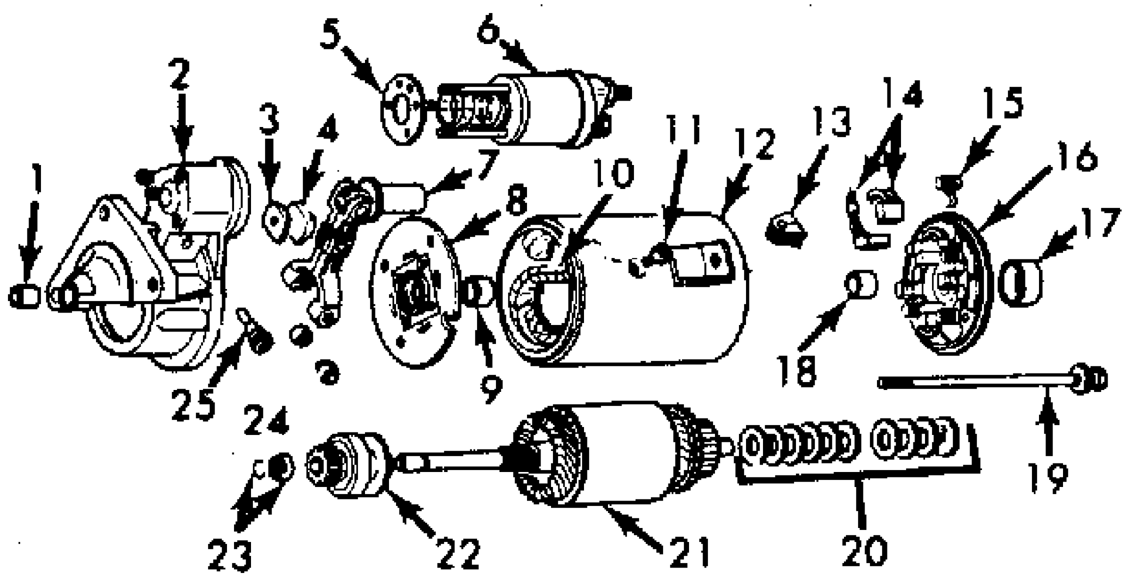
1988 Jeep Cherokee

Starters
JEEP PARIS-RHONE

Cherokee, Comanche, Wagoneer

DESCRIPTION

Starter is a 4-pole, 4-brush type direct series wound motor. The engagement mechanism is integral with the starter and controls switching on and off of motor and shifting of the starter pinion.



1. End Housing Bushing
2. Drive-End Housing
3. Spacer
4. Pad
5. Solenoid Plate
6. Solenoid
7. Pinion Shift Yoke
8. Support Plate
9. Support Plate Bushing
10. Field Winding & Pole Shoe Sets
11. Pole Shoe Screw
12. Armature Housing
13. Grommet
14. Brush Set
15. Brush Spring
16. Brush Holder
17. Cap
18. Brush Holder Bushing
19. Through Bolts
20. Armature Brake Assembly
21. Armature
22. Starter Drive Pinion
23. Drive Pinion Stop
24. Shift Yoke Pivot Pins
25. Shift Yolk Axle

Fig. 1: Exploded View of Paris-Rhone Starter Motor
Courtesy of Chrysler Motors.

OPERATION

1) Voltage is applied to ignition switch through fuse "B" at all times. Voltage is also applied at all times to the contact on starter solenoid, terminal "B".

2) With ignition switch in "START" position, battery voltage is applied from fusible link "B", to ignition switch, and to the coil of the starter relay to ground.

3) The coil of the starter relay engages closing relay contacts. With start relay contacts closed, battery voltage is applied to starter solenoid. Both solenoid windings are energized.

4) The pull-in and hold-in windings work together to magnetically pull starter gear into ring gear. At the same time the plunger also closes solenoid switch contacts in the starter solenoid. Full battery voltage is now applied directly to the starter motor and it cranks the engine.

NOTE: Use the amperage draw reading after the starter motor has obtained its maximum RPM.

TROUBLE SHOOTING

* Check the battery for a broken or cracked casing.
* Check that all connections to battery and starter are clean and tight.
* Check electrolyte level of battery. Levels that are too high or too low may cause poor starter motor performance.
* Check battery by measuring specific gravity of electrolyte in each cell with a hydrometer.

NOTE: No further testing or troubleshooting procedures available from manufacturer.

STARTER SPECIFICATIONS

STARTER MOTOR SPECIFICATIONS TABLE

Application	Specification
Cold Cranking Voltage (Minimum)	9.6 Volts
Cold Cranking Amps	
Cherokee & Wagoneer	350 Amps
Comanche	120 Amps

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS TABLE

Application	Ft. Lbs. (N.m)
Left Side Engine Mount-to-Block	40 (54)
Left Side Engine Mount-to-Bell Housing Bolt	35 (47)
Left Side Engine Mount-to-Frame Sill Bolt	48 (65)
Starter Mounting Bolts	37 (50)
	INCH Lbs. (N.m)
Starter Relay "B+" Terminal Nut	18 (2)

STARTER REMOVAL & INSTALLATION

1988 Jeep Cherokee

1988 Starters
REMOVAL

All Jeep Models

REMOVAL & INSTALLATION

JEEP

Disconnect battery ground cable. Remove electrical wiring from starter or solenoid (Bosch). Remove starter mounting bolts. Remove starter and bracket from bellhousing. To install, reverse removal procedure. Tighten to specifications.

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS TABLE

Application	Ft. Lbs. (N.m)
Jeep	37 (50)

STEERING COLUMN SWITCHES

1988 Jeep Cherokee

1988 STEERING
Jeep Steering Column Switches

All Models

REMOVAL & INSTALLATION

TURN SIGNAL & HAZARD FLASHER SWITCHES

Removal & Installation

1) Place front wheels in straight-ahead position. Disconnect battery negative cable. Remove the steering wheel. Refer to the STEERING WHEEL & HORN REMOVAL article.

2) On models with A/T, place selector lever in "PARK" position. Remove selector lever retaining pin and lever. Using 2 screwdrivers, remove lock plate cover. On models with tilt column, remove tilt lever.

3) Using Plate Compressor (J-23653-A), compress lock plate. If shaft has metric threads, use Metric Forcing Screw (J-23653-4) prior to installing compressor on shaft. Remove and discard lock plate snap ring. Remove plate compressor

NOTE: The lock plate is under strong spring tension. DO NOT attempt to remove snap ring without using lock plate compressor.

4) Remove lock plate, canceling cam, upper bearing preload spring, spring seat and bearing race (thrust washer on some models). Depress hazard warning switch while unscrewing from column.

5) On vehicles with A/T, use a paper clip to compress lock tab retaining shift quadrant light wire in connector block. Disconnect wire. On all models, remove turn signal lever attaching screw and lever.

6) On vehicles with cruise control, disconnect 2 of 4 wires at switch connector. Fold wires back along harness. Tape wires to harness. Tape a string to harness to aid in removal.

7) Disconnect turn signal switch wire harness at bottom of steering column. Tape around turn signal switch harness connector to aid in removal. Remove turn signal switch attaching screws. Remove switch. To install, reverse removal procedure.

LOCK CYLINDER

Removal

1) Remove horn button and steering wheel. Refer to the STEERING WHEEL & HORN REMOVAL article. Remove turn signal switch. Remove key warning buzzer switch and contacts as an assembly, using needle-nose pliers.

2) On models with standard column, turn ignition lock cylinder (clockwise) 2 detent positions beyond the "OFF/LOCK" position. On models with tilt column, turn lock cylinder to "LOCK" position. On all models, compress lock cylinder retaining tab and remove lock cylinder from housing. See Fig. 1.

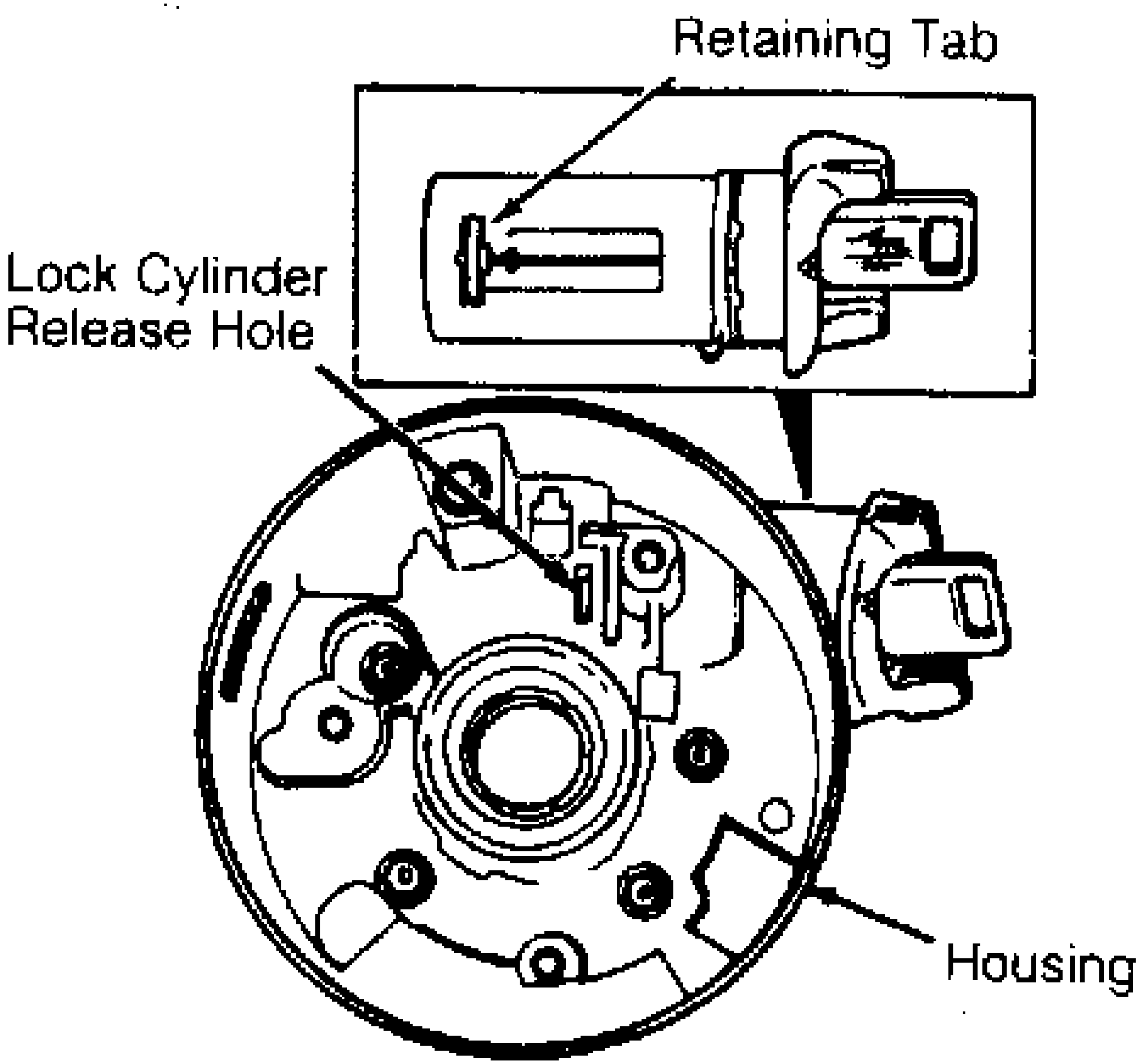


Fig. 1: Removing Jeep Lock Cylinder
Courtesy of Chrysler Motors

Installation

1) To install, insert key in lock cylinder. Hold cylinder sleeve while turning key clockwise until key stops. Align lock cylinder retaining tab with keyway in housing. Insert cylinder into housing.

2) Push lock cylinder inward until it contacts lock sector. Rotate cylinder to engage it with lock sector. Push lock cylinder inward until cylinder retaining tab engages in housing groove. To complete installation, reverse removal procedure.

IGNITION SWITCH

Removal (Cherokee, Wagoneer & Wrangler)

Remove lower instrument panel trim panel. Insert key in lock

cylinder. Turn cylinder to "OFF-UNLOCK" position. Disconnect switch from remote rod. Disconnect harness connectors at switch. Remove switch.

Installation

Move switch slider to "ACC" position. Engage remote rod in switch slider. Position switch on column, taking care not to move slider. Hold key in "ACC" position while pushing switch down slightly to remove slack in actuator rod. Install attaching screws. Connect harness connectors.

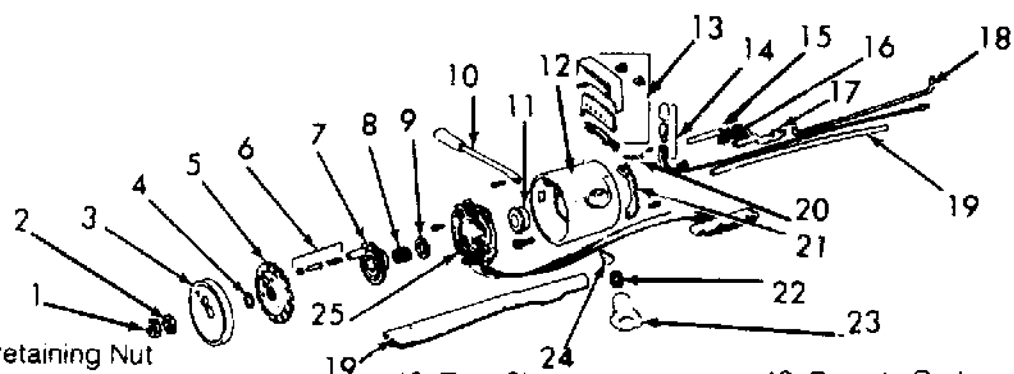
IGNITION SWITCH

Removal (Comanche & Grand Wagoneer)

Remove lower instrument panel trim panel. Insert key in lock cylinder. Turn cylinder 2 positions beyond the "OFF-UNLOCK" position. Disconnect switch from remote rod. Disconnect harness connectors at switch. Remove switch.

Installation

Move switch slider to "ACC" position. Move switch slider back 2 clicks to "OFF-UNLOCK" position. Engage remote rod in switch slider. Position switch on column. DO NOT move slider while positioning switch. Install attaching screws. Connect harness connectors.



1. Steering Wheel Retaining Nut
2. Washer
3. Lock Plate Cover
4. Snap Ring
5. Lock Plate
6. Horn Contact Pin, Retainer & Spring
7. Cancelling Cam
8. Upper Bearing Preload Spring
9. Thrust Washer
10. Turn Signal Lever
11. Thrust Cup
12. Housing
13. Indicator Assembly
14. Indicator Light
15. Lock Bolt
16. Spring Washer
17. Lock Rack
18. Remote Rod
19. Harness Cover
20. Rack Preload Spring
21. Shift Gate Lock
22. Sector
23. Ignition Lock Cylinder
24. Hazard Knob
25. Turn Signal Switch

Fig. 2: Exploded View of Jeep Steering Column Switch Assemblies
Courtesy of Chrysler Motors

TROUBLE SHOOTING

Refer to TROUBLE SHOOTING - BASIC PROCEDURES article in the GENERAL TROUBLE SHOOTING section.

STEERING COLUMN

1988 Jeep Cherokee

1988 STEERING
Jeep Steering Columns

All Models

DESCRIPTION

All models use collapsible steering columns. All columns have integral ignition switch and locking device. Optional tilt wheel is available with both A/T and M/T. Transmission shift linkage is integral on all models except those with floor shift.

TROUBLE SHOOTING

Refer to TROUBLE SHOOTING - BASIC PROCEDURES article in the GENERAL TROUBLE SHOOTING section.

REMOVAL & INSTALLATION

NOTE: Steering column removal and installation procedures refer to all manufacturers. Not all procedures, however, apply to all models.

STEERING COLUMN (COLUMN SHIFT)

Removal

1) Disconnect battery negative cable. Disconnect transmission shift cable rod by prying rod from grommet in shift lever. Remove cable clip. Remove cable from lower bracket.

2) Disconnect, as equipped, either the flexible coupling, "Pot" coupling or "U" joint from pinion shaft.

3) Disconnect wiring connectors at column jacket. Remove steering wheel and horn pad. See STEERING WHEEL & HORN REMOVAL article. Remove damper assembly (if equipped). On RWD models, remove turn signal lever.

4) On all models, remove steering column-to-floor pan attaching screws. Expose steering column bracket. Remove instrument panel steering column cover. Lower reinforcement. Disconnect bezel. Remove indicator set screw and gearshift pointer from shift housing.

5) Remove steering column bracket-to-instrument panel attaching nuts. Lower support bracket. Firmly grasp steering column assembly and pull rearward while disconnecting lower stub shaft from pinion shaft coupling.

NOTE: On vehicles equipped with cruise control and M/T, take care not to damage clutch pedal cruise control switch.

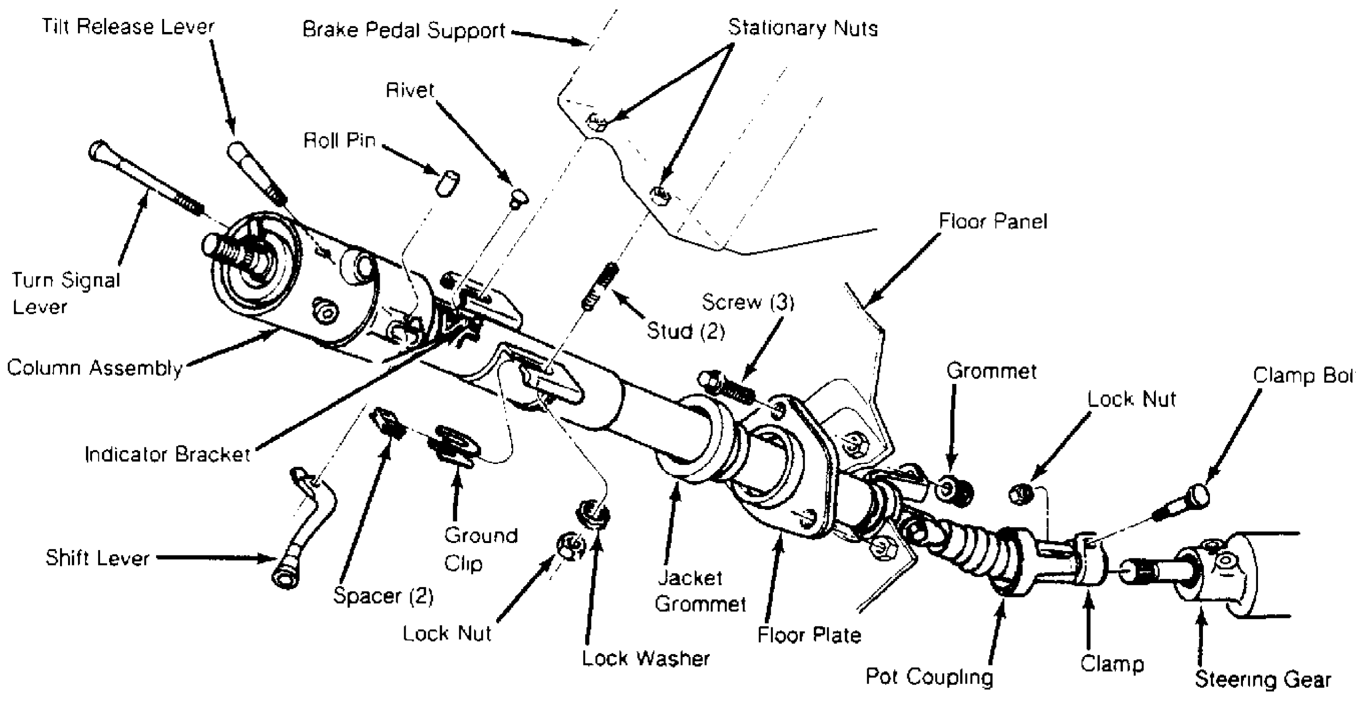


Fig. 1: Exploded View of RWD Steering Column Major Assemblies

Installation

1) On all models, aligning lower shaft with lower coupling and insert shaft. Raise column assembly into position onto studs. Loosely install nuts and washers in breakaway capsules. Pull column rearward. Tighten nuts to specification. See TORQUE SPECIFICATIONS.

2) Install a new shift lever grommet using pliers and back-up washer to snap the grommet into place. Use a multipurpose grease to aid installation.

3) Connect gearshift cable rod to shift lever by snapping rod into grommet with pliers. Adjust linkage. Place steering wheel on shaft with master splines aligned. Place damper assembly inside steering wheel (if equipped). Install steering wheel retaining nut. Tighten to 45 ft. lbs. (61 N.m).

4) Install horn pad assembly. Refer to procedures in the STEERING WHEEL & HORN REMOVAL article. Connect wiring connectors at steering column jacket. Connect battery negative cable. Test operation of lights and horn.

5) On models with A/T, install gearshift indicator pointer. Slowly move gearshift lever from "LOW" position to "PARK" position, pausing briefly at each selector position. Loosen and readjust to align pointer with each position (if necessary). Install instrument panel steering column cover.

STEERING COLUMN (FLOOR SHIFT)

The steering column with a floor mounted gearshift is basically the same as previously described. Standard columns and service procedures are identical except as described below.

* In place of rotating shift housing, there is a plastic shroud which is fixed to lock housing. Shroud covers jacket and lock inhibitor assembly. It is held in place by a tab that fits under side cover and one screw. Shroud can only be replaced by removing lock housing from jacket.

* The lock inhibitor assembly consists of a lever that engages lock levers (preventing locking of steering shaft), a button to operate lever and a return spring. Assembly is attached to lock housing in same location as shift gate is on column shift. Lower steering shaft bearing is mounted in an aluminum support.
* A spring is attached between shift housing and column jacket. This spring keeps housing rotated counterclockwise against rubber bumper.

OVERHAUL

STANDARD COLUMN

NOTE: All columns are similar except for appearance of covers. Some models use ignition key light, while others do not. Disassembly and reassembly procedures cover all models. Some procedures may not apply to every steering column.

Disassembly

1) Pry out wiring trough retainers. Lift off trough. New retainers may be required for reassembly. Use masking tape to protect paint and a deep socket to back-up housing. Drive retaining roll pin out with a punch to remove shift lever.

2) Remove breakaway capsules. Secure column in vise by clamping at column bracket. DO NOT distort column. Remove turn signal lever cover-to-lock housing attaching screws. Remove cover. Remove wiper/washer switch assembly. Pull switch cover up wiper/washer lever. Remove lever sleeve-to-switch attaching screws.

3) Rotate wiper/washer shaft to full clockwise position. Remove shaft from switch. Remove turn signal switch and upper bearing retaining screws. Remove retainer. Lift switch upward out of way. Unclip horn ground wire. Remove ignition key light retaining screw. Lift ignition key light out of way.

4) Remove bearing housing-to-lock attaching screws. Remove snap ring from upper end of steering shaft. Remove bearing housing from shaft. Remove lock plate spring and lock plate from shaft. Remove shaft through lower end of column.

5) Remove ignition key. Remove warning switch retaining screw. Lift out key warning switch. Remove 2 ignition switch-to-column jacket retaining screws. See Fig. 2. Remove ignition switch by rotating switch 90 degrees on actuator rod. Remove 2 dimmer switch retaining screws. Disengage dimmer switch from rod.

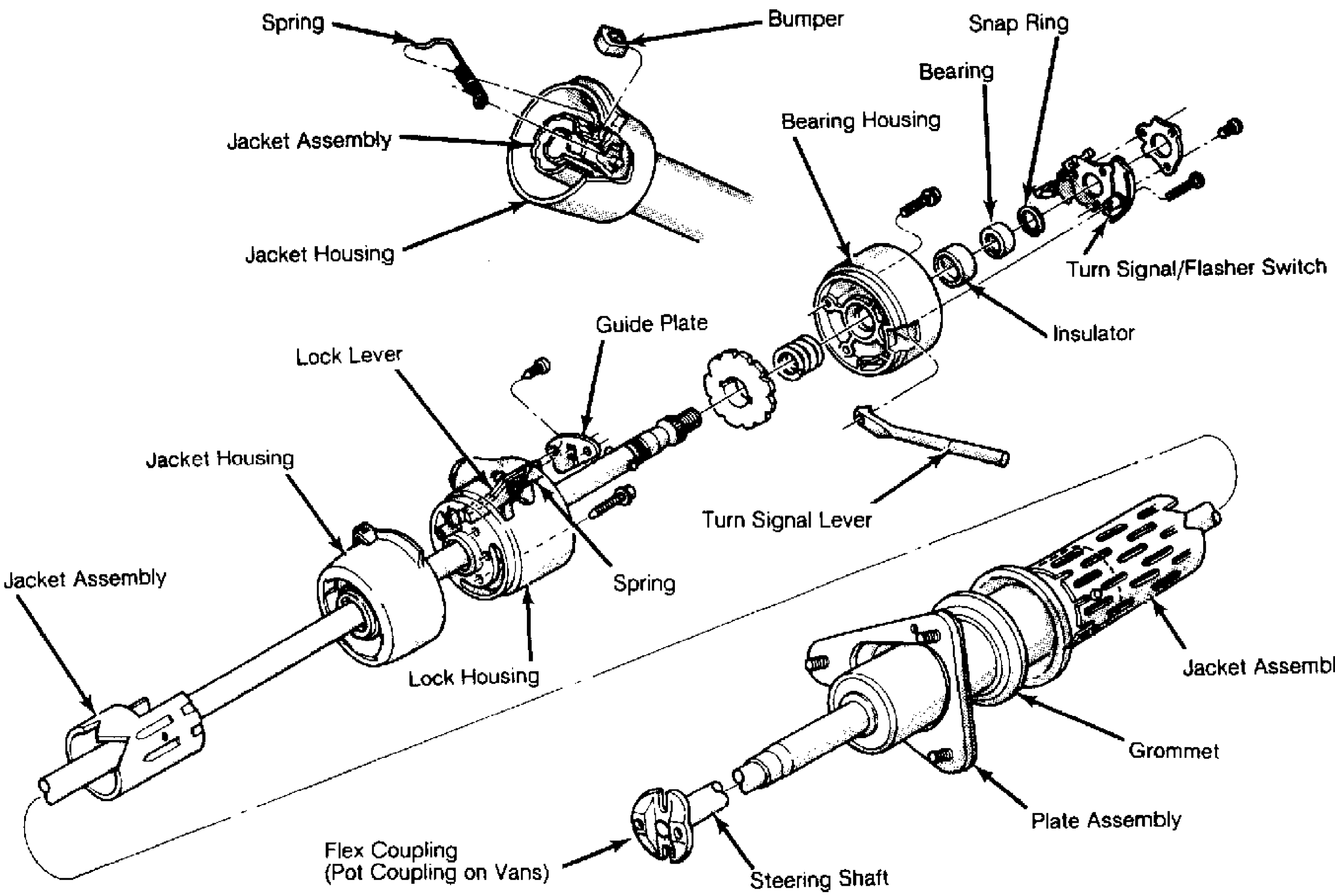


Fig. 2: Removing Ignition Switch

6) Remove bellcrank mounting screws. Slide bellcrank up in housing until it can be disconnected from ignition switch rod. Using key, place cylinder in "LOCK" position. Remove key.

7) Using a small diameter screwdriver or similar tool, push inward to release spring-loaded lock retainer while pulling lock cylinder from housing bore. Pull lock lever and spring assembly out of housing as an assembly.

8) Remove 4 lock housing-to-column jacket retaining screws. Remove housing from jacket. On A/T models, loosen shift tube set screw in shaft housing. On all models, using Shift Tube Remover (J-23072 for Jeep), remove tube through lower end of jacket. See Fig. 3.

9) To disassemble flexible coupling, remove 4 bolts and 2 cross straps. Remove flexible coupling. "Pot" coupling is removed by prying cover tangs from coupling body and lifting seal and cover from body. Drive dowel pin down into coupling. Discard "Pot" coupling. Pull body off shaft and shoe assembly.

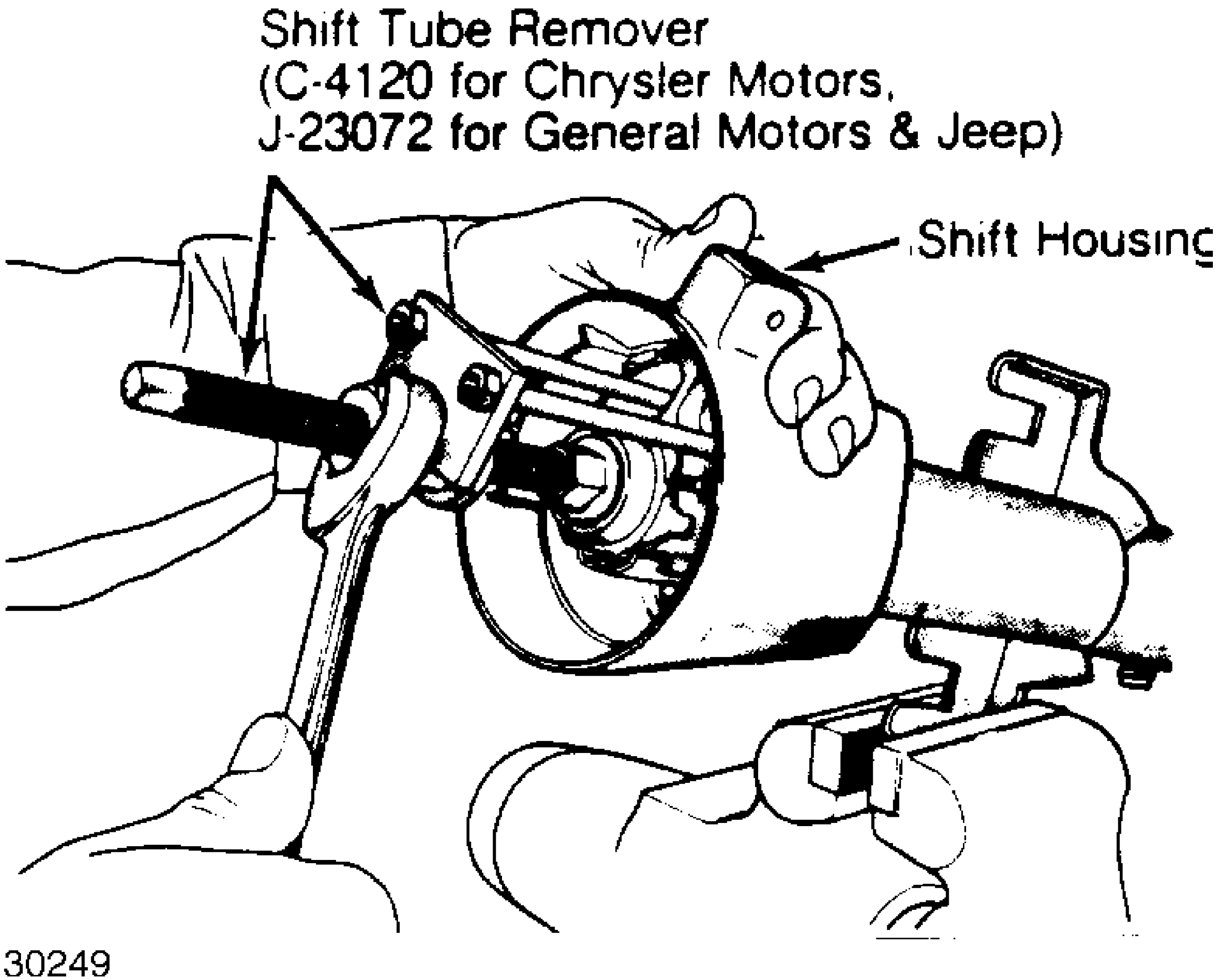


Fig. 3: Removing Shift Tube

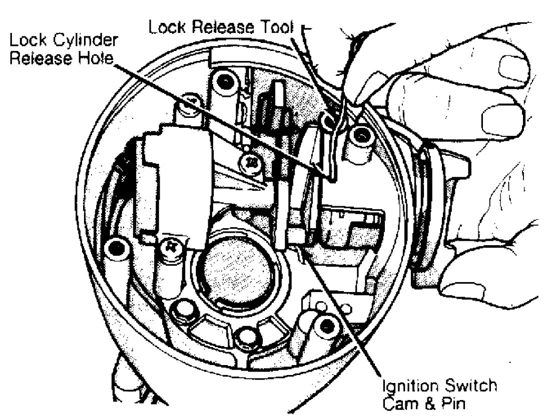


Fig. 4: Removing Lock Cylinder

Reassembly

1) Coat all friction surfaces with grease. Clamp column in vise so that both ends of column are accessible. Check column tube-to-

mandrel rivets for tightness.

2) Use new 1/8" diameter by 1/4" long (1/8" grip) aluminum blind rivets (if necessary). DO NOT use steel rivets as rivets must shear upon impact. Position crossover load spring and shift lever in gearshift housing. Tap pivot pin into place. See Fig. 5.

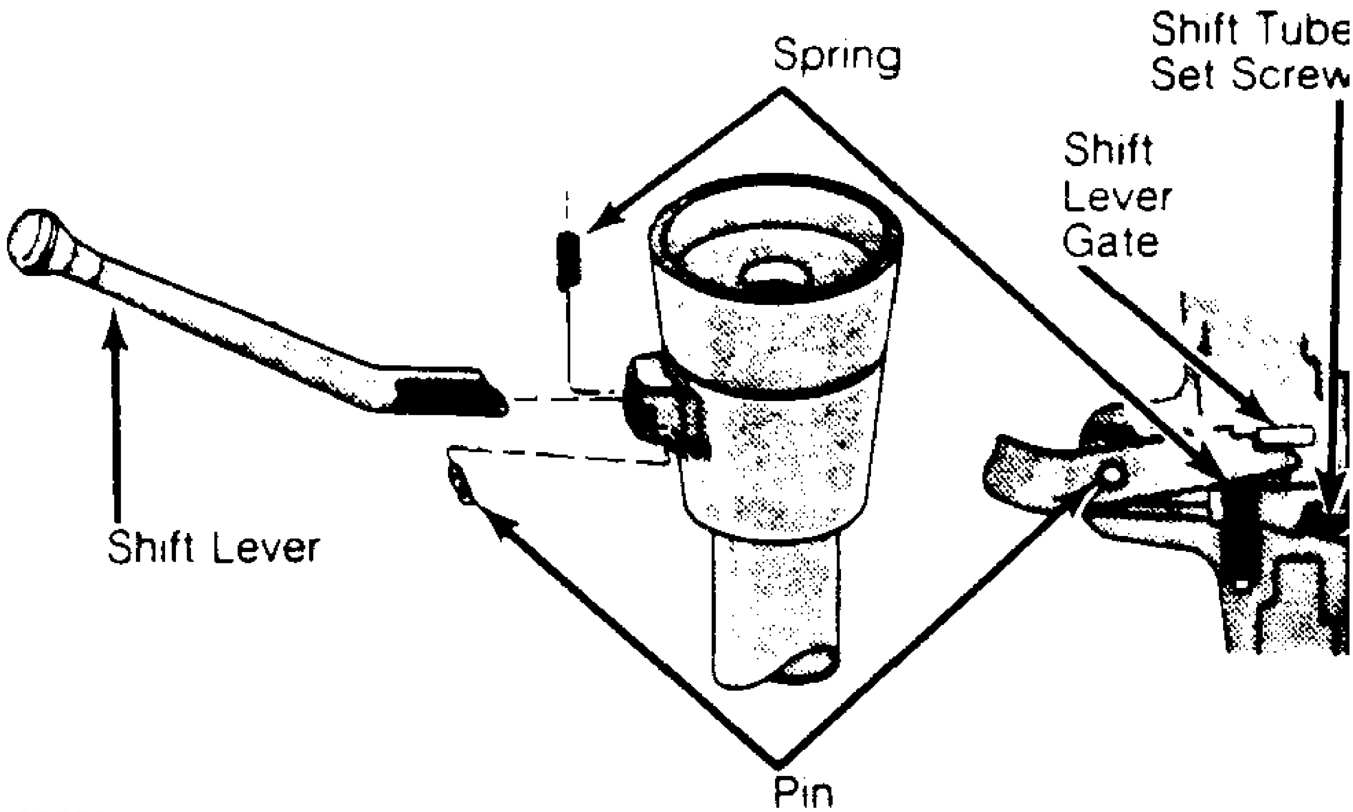


Fig. 5: Installing Column Shift Lever
Courtesy of Chrysler Motors

3) Assemble key cylinder plunger spring. Install assembly on lock housing. Install shift lever gate on lock housing. Place shift lever in mid position (if equipped). Seat lock housing on top of jacket by aligning keyway in housing with slot in jacket. Install housing-to-jacket screws. Tighten alternately to 90 INCH lbs. (10 N.m).

4) Install dimmer switch rod by firmly pushing rod into switch. Compress switch until 2 (.093") drill bit shanks can be inserted into alignment holes. Reposition upper end of push rod in pocket of wiper/washer switch. Remove lower column cover (if necessary). Remove drill bits.

5) Switch should click when lever is lifted and again as lever returns, just before it reaches stop in down position. Grease and assemble 2 lock levers, lock lever spring and pin. See Fig. 6. Install assembly into lock housing. Seat pin firmly in bottom of slots. Ensure that lock lever spring leg is firmly in place in lock casting notch. See Fig. 7.

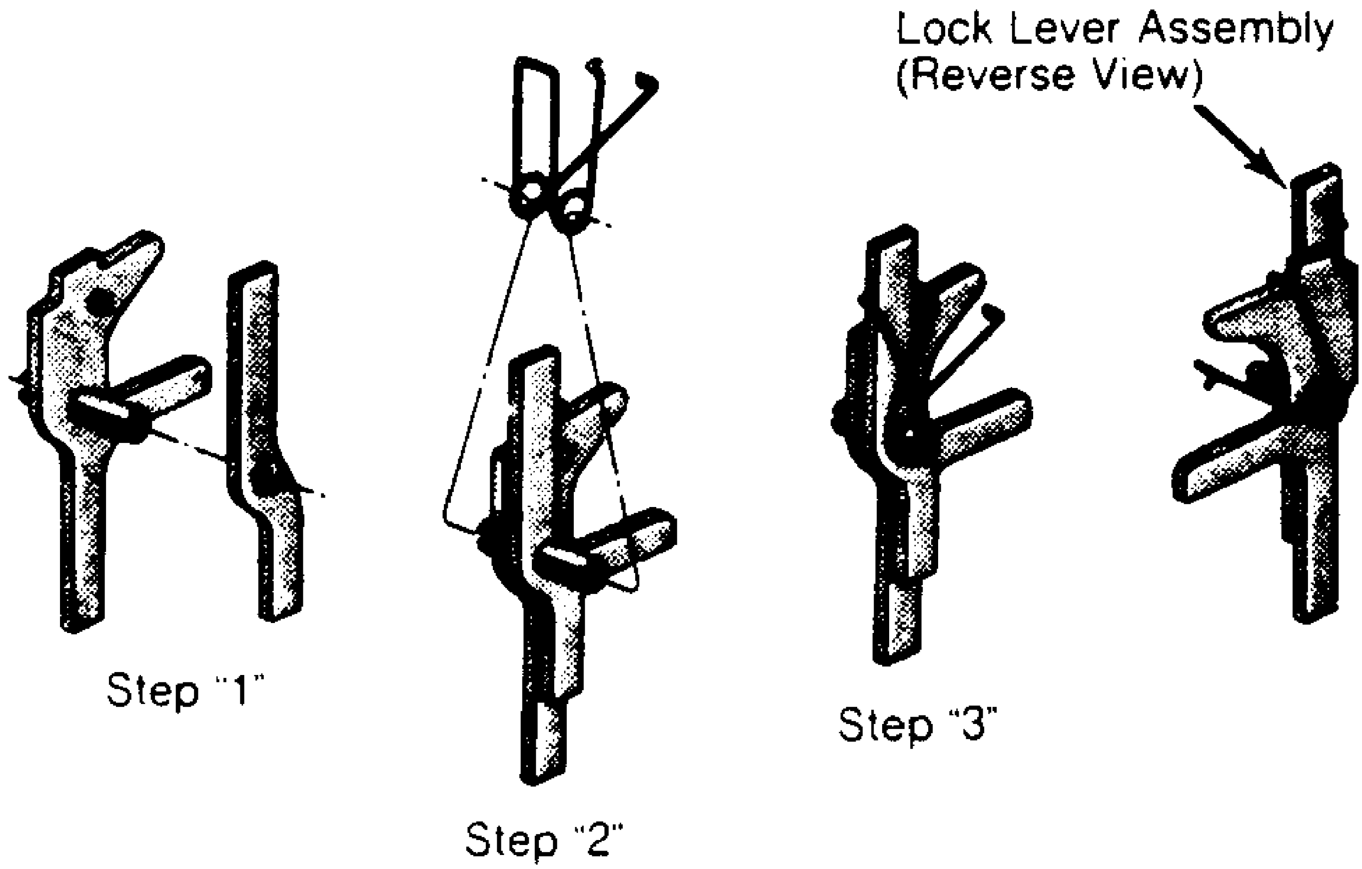


Fig. 6: Assembling Lock Lever & Spring Assembly

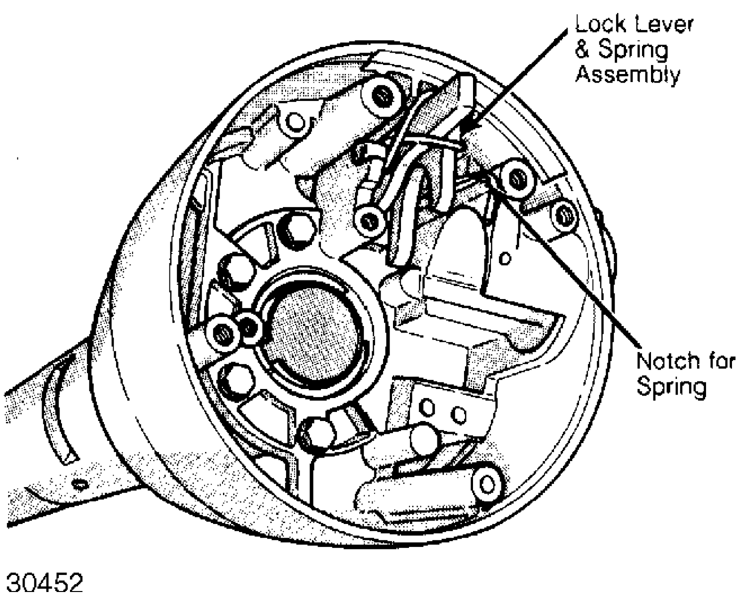


Fig. 7: Installing Lock Lever & Spring Assembly

6) Install ignition switch actuator rod from bottom through oblong hole in lock housing. Attach rod to bellcrank. Position bellcrank assembly into lock housing while pulling ignition switch and

rod down column. Install bellcrank onto its mounting surface. Gearshift lever should be in "PARK" position.

7) Place ignition switch on actuator rod. Rotate switch 90 degrees to lock rod into position. Install ignition lock by turning key to "LOCK" position. Remove key. Insert cylinder into housing far enough to contact switch actuator. Insert key. Press inward. Rotate cylinder.

8) When parts align, cylinder will move inward and spring loaded retainers will snap into place, locking cylinder in housing. With cylinder and ignition switch in "LOCK" position, tighten ignition switch mounting screws.

9) Feed key warning switch wires behind wiring post and down through space between housing and jacket. Remove ignition key. Position cylinder in housing. Tighten mounting screws. Install lower bearing support (floor shift), bearing and spring on steering shaft.

10) Install and lubricate rubber "O" ring in lower groove on upper end of steering shaft. Insert steering shaft assembly into column assembly. Press upper bearing into upper bearing housing. Bearing must be fully seated.

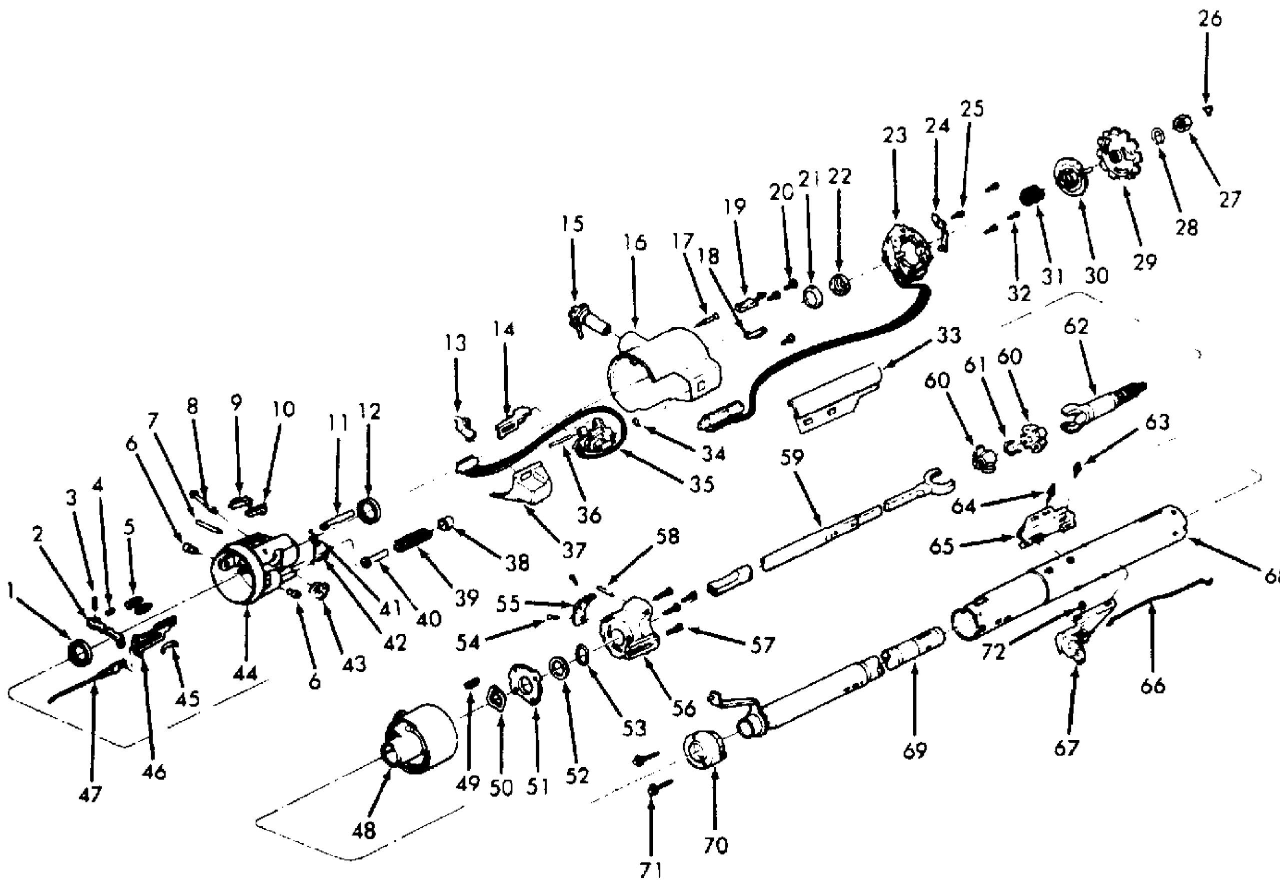
11) Push up on steering shaft to compress bearing and spring. Hold shaft in this position until snap ring is installed. Install lock plate on steering shaft. Install upper bearing spring. Install upper bearing housing with bearing previously installed. Tighten bearing housing retaining screws to 35 INCH lbs (4 N.m).

12) Install upper bearing snap ring on steering shaft, locking assembly into position. Install 4 screws attaching bearing housing to lock housing. Install ignition key lamp assembly in bearing housing. Install turn signal switch in bearing housing.

13) Feed turn signal switch and ignition key lamp wires through opening between bearing housing and lock housing and down along bottom of jacket. Install bearing retainer plate. Tighten screws. Ensure that ground wires from turn signal switch are positioned toward ground clips before tightening.

14) Assemble wiper switch, shaft, cover or speed control switch, switch cover and knob. Place wiper/washer switch assembly into lock housing, feeding wires through lock housing. Fasten wires to turn signal switch. Install dimmer switch rod and dimmer switch.

15) Install turn signal lever cover. Install breakaway capsules. Install wiring trough in place, being careful not to pinch wires. Install new retainers (if necessary).



1. Bearing Assembly
2. Shoe Release Lever
3. Release Lever Pin
4. Release Lever Spring
5. Spring
6. Pivot Pin
7. Dowel Pin
8. Drive Shaft
9. Steering Wheel Lock Shoe
10. Steering Wheel Lock Shoe
11. Lock Bolt
12. Bearing Assembly
13. Tilt Lever Opening Shield
14. Dimmer Switch Rod Activator
15. Cylinder Lock Assembly
16. Lock Housing Cover
17. Lock Retaining Screw
18. Buzzer Switch Retaining Clip
19. Buzzer Switch Assembly
20. Screw
21. Inner Race
22. Inner Race Seat
23. Turn Signal/Flasher Switch Assembly
24. Turn Signal Arm Assembly
25. Screw
26. Retainer
27. Jam Nut
28. Retaining Ring
29. Lock Plate
30. Turn Signal Cancelling Cam
31. Spring
32. Screw
33. Wiring Trough
34. Pin Preload Spring
35. Pivot & Switch Assembly
36. Switch Actuator Pivot Pin
37. Column Cover End Cap
38. Spring Retainer
39. Tilt Spring
40. Spring Guide
41. Spring
42. Screw
43. Switch Actuator Sector
44. Steering Column Housing
45. Rack Preload Spring
46. Switch Actuator Rack
47. Ignition Switch Actuator
48. Gearshift Lever Bowl
49. Shift Lever Spring
50. Wave Washer
51. Jacket Mounting Plate
52. Thrust Washer
53. Shift Tube Retaining Ring
54. Screw
55. Shift Lever Gate
56. Column Housing Support
57. Screw
58. Dowel Pin
59. Lower Steering Shaft Assembly
60. Centering Sphere
61. Joint Preload Spring
62. Race & Upper Shaft Assembly
63. Screw
64. Mounting Stud
65. Ignition Switch Assembly
66. Dimmer Switch Rod
67. Dimmer Switch Assembly
68. Steering Column Jacket
69. Shift Tube Assembly
70. Adapter & Bearing Assembly
71. Screw
72. Nut

30254

Fig. 8: Exploded View of Tilt Steering Column

TILT WHEEL COLUMN

Disassembly

1) Remove lower bracket assembly-to-lower bearing support bolts. On column shift models, remove shift housing cover. On floor shift models, unsnap and remove shroud extensions. Remove wiring protector from column jacket.

2) Mount column in vise at capsule bracket. Mount Holding Fixture (C-4132) onto column. Mount holding fixture and column in vise.

3) Remove tilt lever. To remove hazard warning knob, push in knob while unscrewing. Remove ignition key light assembly. Pull knob off wiper/washer switch assembly. Pull hider up switch lever. Remove 2 sleeve-to-wiper/washer switch retaining screws. Remove sleeve.

4) Rotate shaft in wiper switch fully clockwise. Remove shaft by pulling straight out of wiper/washer switch. Carefully remove plastic cover from lock plate. Using Lock Plate Depressor (J-23653-A for Jeep), depress lock plate. Pry retaining ring from groove.

5) Remove lock plate, canceling cam and upper bearing plate. Remove switch actuator screw and arm. Remove 3 turn signal switch attaching screws. Place shift bowl in "LOW" position. Wrap a piece of tape around wires to prevent snagging when removing switch. Remove switch and wiring.

6) Remove key light. Place lock cylinder in "LOCK" position. Insert a small screwdriver into slot next to switch mounting screw boss. Depress spring latch at bottom of slot. Remove lock.

7) Using a paper clip, remove key warning switch. Bend one end of clip into a hook. Insert hook into exposed loop of wedge spring. Pull clip. Remove spring and switch. DO NOT allow spring to fall into steering column.

8) Remove 3 housing cover screws. Remove housing cover. Remove wiper/washer switch. Using a punch, press out wiper switch pivot pin (if necessary). Tilt lever opening shield and dimmer switch actuator rod may be removed from cap (if necessary).

9) Place column in fully upright position. Using a large Phillips screwdriver, remove tilt spring retainer. Insert screwdriver in opening. Push in approximately 3/16". Turn approximately 1/8 turn clockwise until ears align with grooves in housing. Remove spring and guide.

10) Remove dimmer switch mounting screws. Remove dimmer switch. Separate dimmer switch from rod by pulling on rod. Push upper steering shaft in far enough to remove steering shaft inner race seat and inner race. With ignition switch in "ACC" position, remove ignition switch mounting screws and switch. Place Pivot Pin Remover (J-21854-01 for Jeep) over pivot pin. Thread small portion of screw firmly into pin.

11) Hold screw from turning with one wrench while turning nut clockwise with a second wrench to withdraw pivot pin from support. Remove opposite pivot pin in same manner. Use tilt release lever to disengage lock shoes. Remove bearing housing assembly by pulling upward to extend rack fully.

12) Move housing assembly left to disengage rack from actuator. Rotate housing clockwise to free dimmer switch actuator rod. Remove activator assembly. Remove coupling from lower end of steering shaft. Double coupling is retained to shaft with a roll pin. Remove shaft assembly from upper end.

CAUTION: DO NOT drop or bump steering shaft as plastic pins may shear.

13) Disassemble steering shaft assembly by removing center spheres and anti-lash springs. See Fig. 9. Remove 4 bolts securing support to lock plate. Remove support from end of column jacket. Remove 2 attaching screws and shift gate from support (if necessary). Dimmer switch is removed with support.

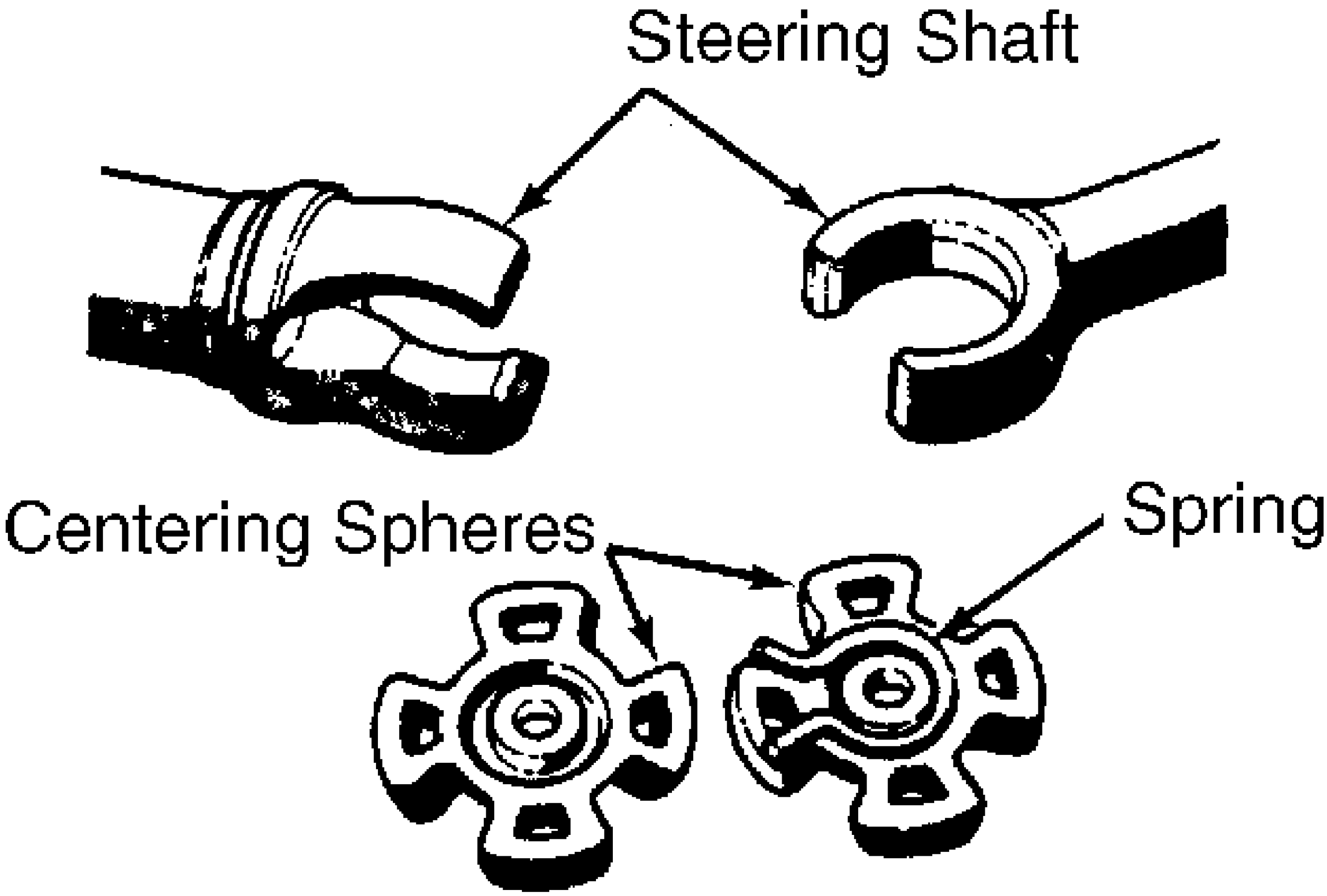


Fig. 9: Shaft Centering Spheres

14) Using a screwdriver, remove shift tube retaining ring. Remove thrust washer. Remove 2 screws from lower bearing. Remove lower bearing from jacket. Using Puller (J-23073-01 for Jeep), remove shift tube from bowl. Insert bushing on end of puller in shift tube to force tube from bowl. DO NOT hammer shift tube as plastic joints may shear.

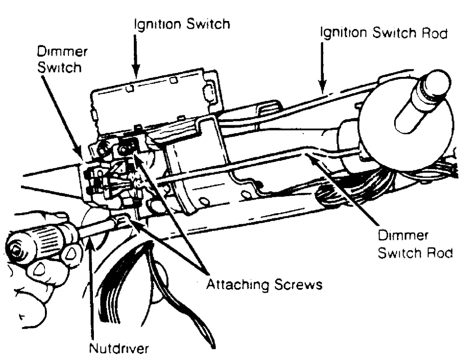


Fig. 10: Removing Shift Tube from Bowl on Models With Tilt Wheel

15) From lower end of jacket, remove shift tube from jacket. Remove jacket mounting plate by sliding from jacket notches and tipping down toward bowl hub at 12 o'clock position under jacket

opening. Remove wave washer. Remove bowl from jacket. Remove shift lever spring from bowl by winding spring up with pliers and pulling out.

16) By removing spring retaining screw and moving spring clockwise, remove lock bolt spring. Using a hammer and punch, lightly tap drive shaft from sector. Remove drive shaft, sector and bolt. Remove rack, spring and shim (if used). Remove tilt release lever pin.

17) Relieve load on lever release by holding shoes inward. Wedge a block between top of shoes and bearing housing. Remove release lever and release lever spring. Using punch and hammer, remove lock shoe pin. Remove lock shoes and lock shoe springs.

18) Remove bearings from bearing housing only if they are to be replaced. Remove separator and ball from bearing. Place housing on work bench. Using a punch against back surface of race, hammer race from housing. DO NOT reuse bearings.

Reassembly

1) During reassembly, coat all friction surfaces with multipurpose grease. Clamp column in vise so that both ends of column are accessible. Install bearings in bearing housing (if removed).

2) Install lock shoe springs, lock shoes and shoe pin in bearing housing. Use a .180" rod to line up shoes for pin installation. With tilt lever opening on left side and with the shoes facing up, the 4 slot shoe should also face up.

3) Install spring, release lever and pin in bearing housing. Install drive shaft in housing. Lightly tap sector onto drive shaft far enough to bottom on shaft. Install lock bolt. Engage lock bolt with sector cam surface. Install rack and spring. Block tooth on rack should engage block tooth on sector.

4) Install external tilt release lever. Install bolt spring and spring retaining screw. Tighten to 35 INCH lbs. (4 N.m). Install shift lever spring in bowl by winding up with pliers and pushing in. Slide bowl into jacket. Install wave washer and jacket mounting plate.

5) Work jacket mounting plate into jacket notches by tipping jacket mounting plate toward bowl hub at 12 o'clock position and under jacket opening. Slide jacket mounting plate in jacket notches. Carefully install shift tube in lower end of jacket.

6) Align key in tube with keyway in bowl. Using Puller (J-23073-01 for Jeep), pull shift tube into bowl. See Fig. 11. DO NOT push or tap on end of shift tube. By pulling bowl up and compressing wave washer, install thrust washer and retaining pin.

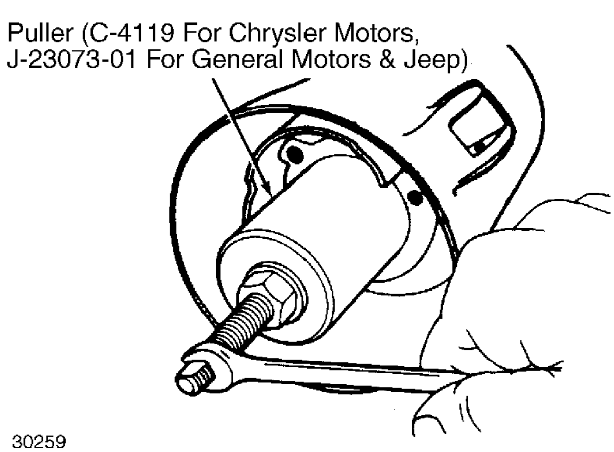


Fig. 11: Installing Shift Tube on Models With Tilt Wheel

7) Slide dimmer switch actuator rod through hole in support. Feed rod between bowl and jacket. Install support by aligning notch in support with notch in jacket. Insert 4 screws through support into

jacket mounting plate. Tighten screws to 60 INCH lbs. (7 N.m). Install lower bearing on lower end of jacket (if removed).

8) Install centering spheres and anti-lash spring in upper steering shaft. Install lower steering shaft from same side of spheres that spring ends protrude. Perform a trial fit of assembly to ensure that master serration of upper shaft is on same side as master serration of lower shaft assembly.

9) Position shift bowl fully counterclockwise. Install ignition switch actuator rod between bowl and jacket from bottom. Guide back of coupling into support slot. Assemble bearing housing over steering shaft. Engage rack over end of ignition switch actuator rod.

10) Position access hole of bearing housing over end of dimmer switch actuator rod. Rotate housing counterclockwise to assemble. Holding lock shoes in disengaged position, assemble bearing housing over steering shaft until pivot holes line up with holes in support.

11) Install pivot pins. Assemble as far as possible, using palm pressure of hand to prevent enlarging support pivot hole. Using a small hammer and punch, tap pins into place. Replace wiper/washer pivot assembly. Press pivot pin in cover (if removed). Check pivot assembly for ease of movement.

12) If movement is restricted, tap other end of pin for clearance. Install wiper/washer switch. Replace tilt lever opening shield in cover (if removed). Position cap over dimmer switch actuator rod. Guide end of actuator rod into pivot slot during cover assembly. Hold cap so that cover will slide over it.

13) Place housing in full upward position. Ensure there is grease between guide and peg on support, tilt spring and tilt spring retainer. Install guide. Using a screwdriver in retaining slot, turn retainer clockwise to engage. Install bearing inner race and seat.

14) Install lock housing cover. Tighten 3 screws to 100 INCH lbs. (11 N.m). Assemble key warning switch to spring clip with formed end of clip under end of switch and with spring bowed away from switch on side opposite contact. Push switch and spring into hole in lock housing cover with contacts facing lock cylinder bore.

15) Install key light (if equipped). Install turn signal switch wires and connector through cover, bearing housing and shift bowl. Push in hazard plunger. Install turn signal switch. Tighten screws to 25 INCH lbs. (3 N.m). Install hazard warning knob and screw. Pull knob out.

16) Install canceling cam spring, canceling cam (carrier assembly) and lock plate. Using Lock Plate Depressor (J-23653-A for Jeep), depress lock plate. See Fig. 12. Install a new retaining ring. Install tilt release lever (if removed). Install turn signal switch lever.

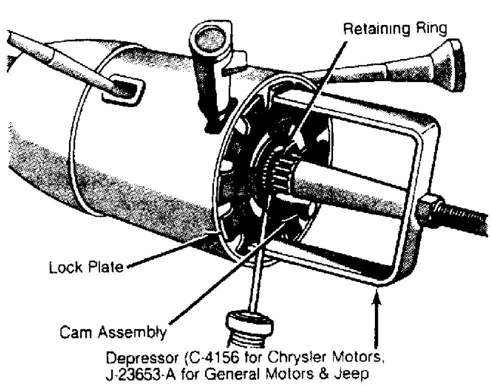


Fig. 12: Installing Lock Plate Retaining Ring

17) Install ignition lock. Turn key to "LOCK" position. Remove key. Insert cylinder into housing far enough to contact shaft. Press inward while moving ignition switch actuator rod up and down to align parts.

18) When parts align, cylinder will move inward and a spring loaded retainer will snap into place locking cylinder in housing. To replace ignition switch, position key cylinder in "LOCK" position. Remove key. Place ignition switch in "LOCK" position (second detent from bottom).

19) Fit ignition switch actuator rod into slider hole. Loosely install on column with 2 screws. Push switch lightly toward lock housing to take out slack in actuator rod. Tighten screws to 34 INCH lbs. (4 N.m). DO NOT move switch out of detent position.

20) Install dimmer switch by firmly seating push rod into switch. Compress switch until 2 (.093") drill bit shanks can be inserted into alignment holes. Reposition upper end of push rod in pocket of wiper/washer switch. Remove lower column cover (if necessary).

21) With a light upward pressure on switch, install 2 screws. Remove drill bits. Switch should click when lever is lifted and again as lever returns, just before it reaches lower stop. Install wire protector over wires on column jacket, being careful not to pinch wires.

22) Remove column from vise. Position lower bracket assembly on steering column. Install 2 bolts. Tighten to 105 INCH lbs. (12 N. m). Aligning master splines, install coupling assembly on steering shaft. Support coupling under joint. Drive in roll pin.

NOTE: DO NOT remove bearings from housing unless they are to be replaced. Install new bearings if bearings are removed from housing. Never reuse old bearings.

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS TABLE

Application	Ft. Lbs. (N.m)
Flexible Coupling Bolts	17 (23)
Steering Wheel Retaining Nut	45 (61)
Support Plate Bolts	17 (23)
	INCH Lbs. (N.m)
Bearing Housing-to-Lock Housing Screws	35 (4)
Bracket-to-Column Bolt	124 (14)
Column Clamp Stud	20 (2)
Column Clamp Stud Nut	106 (12)
Hazard Switch	27 (3)
Housing Cover Screws	100 (11)
Ignition Switch Screws	35 (4)
Lock Housing-to-Jacket	90 (10)
Shift Tube Support Screws	60 (7)
Steering Column Lower Bracket Bolts	106 (12)
Tilt Release Spring Retaining Screw	35 (4)
Turn Signal Retaining Plate	27 (3)
Upper Bracket Nuts	106 (12)

STEERING GEAR - MANUAL

1988 Jeep Cherokee

1988 STEERING
Jeep Manual Steering Gears
Koyo & Saginaw Recirculating Ball

Cherokee, Comanche, Wrangler

DESCRIPTION

Jeep uses the Saginaw steering gear unit. Different models are used. The Model 525 uses 3 bolts in the side cover while the Model 535 uses 4 bolts.

Steering gears are a recirculating ball-type. Proper engagement between sector and ball nut is obtained by adjusting screw. Worm bearing adjuster can be turned to provide proper preloading of upper and lower bearings.

TROUBLE SHOOTING

Refer to TROUBLE SHOOTING - BASIC PROCEDURES article in the GENERAL TROUBLE SHOOTING section.

ADJUSTMENTS

NOTE: Adjust worm bearing preload prior to performing meshload adjustment. If steering gear is removed, install INCH lb. torque wrench on worm shaft to check preload adjustments.

WORM BEARING PRELOAD

1) Place reference mark on pitman arm and sector shaft. Remove pitman arm retaining nut. Using puller, remove pitman arm from sector shaft.

2) Disconnect pitman arm from ball stud or sector shaft.

3) Remove horn pad. Turn steering wheel slowly against one stop then back 1/2 turn. Place an INCH-lb. torque wrench with a maximum reading of 50 INCH lbs. (6 N.m) on steering wheel nut.

4) Measure amount of torque (preload) required to rotate steering wheel at a constant speed for approximately 1 1/2 turns on Ford Motor Co. models or 90 degree arc on all others.

5) Note preload. Adjust preload if not within specification. See WORM BEARING PRELOAD table. Adjust preload by loosening lock nut (if not previously loosened) and rotating worm bearing adjuster to obtain correct preload.

6) Once correct preload is obtained, tighten lock nut to specification. Perform meshload adjustment once correct preload is obtained.

WORM BEARING PRELOAD TABLE

Application	INCH Lbs. (N.m)
Cherokee, Comanche & Wrangler	5-8 (.6-.9)

MESHLOAD ADJUSTMENT

1) Rotate steering wheel from stop-to-stop, noting the number of revolutions. Rotate steering wheel back to the center position.

2) Ensure sector shaft cover bolts are tightened to specification. Using an INCH lb. torque wrench, measure highest torque required to rotate steering wheel back and forth through the center position. Meshload must be adjusted if not within specification. See the MESHLOAD SPECIFICATIONS table.

MESHLOAD SPECIFICATIONS TABLE

Application	INCH Lbs. (N.m)
Cherokee, Comanche & Wrangler	(1) 4-10 (.5-1.1)

(1) - In excess of worm bearing preload. Maximum preload is 18 INCH lbs. (2.0 N.m) on Jeep models or 16 INCH lbs. (1.8 N.m) on all others.

3) Loosen sector shaft adjuster screw lock nut. Adjust sector shaft adjuster screw to obtain correct reading. Tighten lock nut to specification while holding adjusting screw.

4) Reverse removal procedures for components removed. Ensure reference mark is aligned on pitman arm and sector shaft. Tighten pitman arm retaining nut to specification. On Jeep models, stake pitman arm retaining nut in 2 places.

REMOVAL & INSTALLATION

STEERING GEAR

CAUTION: All steering component fasteners are made of special quality materials. Replacement fasteners must be of same part number or equivalent. Tighten all fasteners to proper torque. Install new cotter pin where used.

Removal

1) Disconnect negative battery cable. Set front wheels in straight-ahead position. Note position of steering wheel. Remove flexible coupling shield retaining screw (if equipped).

2) Remove flexible coupling-to-steering worm shaft flange bolts or lower universal joint pinch bolt. Remove sector shaft nut and washer. Place reference mark in relation of pitman arm-to-sector shaft. Using Puller (J-6632-01), remove pitman arm. Remove steering gear-to-frame bolts. Remove steering gear.

Installation

1) Install flexible coupling on worm shaft. Align flat on coupling with flat on worm shaft. Push coupling on shaft until shaft touches shoulder. Install pinch bolt. Pinch bolt must pass through shaft undercut.

2) To install remaining components, reverse removal procedure. Align reference mark on pitman arm and sector shaft. Ensure splines are properly aligned. Tighten bolts to specification. On Jeep models, stake sector shaft nut in 2 areas.

SECTOR SHAFT SEAL

NOTE: On some models, sector shaft seal may be replaced without removing steering box. It may be necessary to remove steering gear to gain access to remove sector shaft seal.

Removal & Installation

1) Place steering gear at center of travel. Remove sector

shaft nut. Place reference mark in relation of pitman arm-to-sector shaft. Using puller, remove pitman arm.

2) Remove sector shaft cover retaining bolts. Lift sector shaft and cover from housing. Using a screwdriver, pry sector shaft seal from housing. Use care not to damage housing area. Note direction of seal installation.

3) Loosen sector shaft adjusting screw lock nut. Rotate adjusting screw clockwise and remove cover from sector shaft. Inspect gear lubricant for contamination. Steering gear must be overhauled if contamination exists.

4) Lubricate new sector shaft seal with steering gear lubricant. Position seal in housing bore. Using proper sized socket, tap seal into housing until it bottoms.

5) Install sector shaft so center tooth of sector shaft enters center tooth of ball nut. Fill housing with lubricant. Install new sector shaft cover gasket on gear housing (if equipped). Apply a thin bead of sealant to sector shaft cover on models which do not use a gasket.

6) Using a screwdriver through the center hole, align adjusting screw and install cover on sector shaft. See Fig. 1. Turn adjusting screw counterclockwise until screw bottoms, then back off 1/4 turn.

7) Coat cover bolts with non-hardening sealant. On all models, install cover retaining bolts. Tighten to specification. Install sector shaft lock nut. Perform adjustments on steering box. See ADJUSTMENTS in this article.

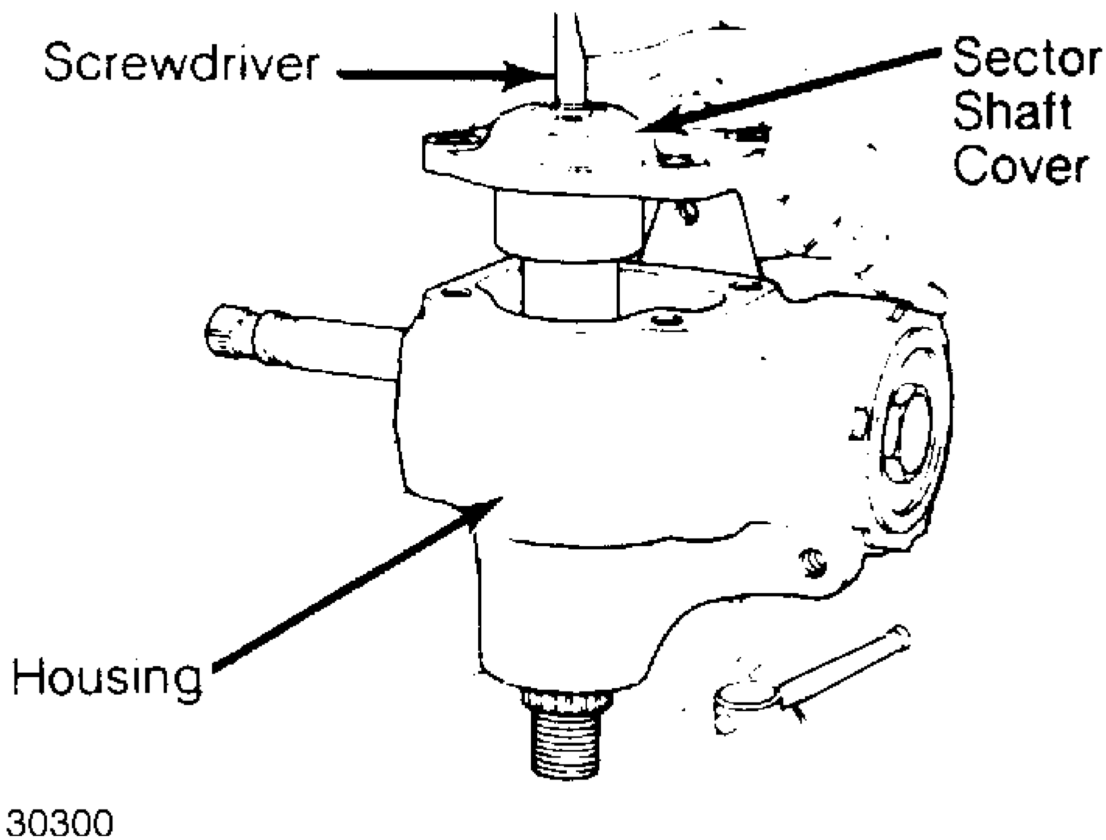


Fig. 1: Installing Sector Shaft Cover

OVERHAUL

STEERING GEAR

Disassembly

1) Place steering gear in a holding fixture. Worm shaft should be centered in steering gear. Remove sector shaft cover bolts. Remove sector shaft and cover from housing.

2) Remove sector shaft adjusting screw lock nut. Rotate adjusting screw clockwise to remove cover from shaft. DO NOT lose shim located on adjusting screw.

3) Loosen worm bearing adjuster lock nut. Remove worm bearing adjuster and worm shaft lower bearing. Remove worm shaft and ball nut assembly from housing. Remove upper bearing.

CAUTION: DO NOT allow ball nut to rotate down worm shaft as ball guides may be damaged.

4) If ball nut fails to rotate smoothly on worm shaft, disassembly is required. Remove ball guide clamp and guides. Rotate worm shaft in both directions to remove balls. Note and record number of balls in each circuit area of the ball nut.

5) Note direction of ball nut on worm shaft prior to removal. Remove ball nut from worm shaft.

CAUTION: Note and record number of balls removed from each circuit of ball nut during disassembly. Determine location of ball nut on worm shaft prior to removal. Ball nut must be installed on worm shaft with shallow teeth in proper direction.

6) Use slide hammer and puller attachment to remove worm bearing adjuster bearing cup. See Fig. 2. Using a bearing driver or socket, remove bearing cup from housing.

7) Remove bearings from housing. Pry out all seals from housing. Note direction of seals.

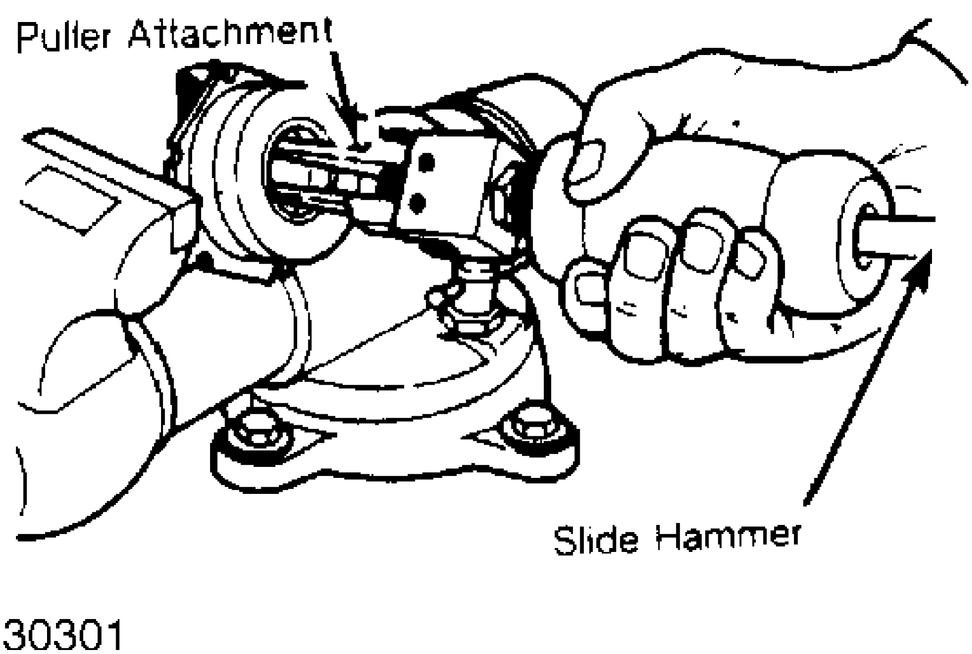


Fig. 2: Removing Worm Adjuster Bearing Cup

Cleaning & Inspection

1) Clean components with solvent and dry with compressed air. Inspect bearings and races for signs of wear. Inspect ball nut and

worm shaft for wear or pitting.
        2) Inspect sector shaft fit at side cover bushing assembly (if equipped). Bushing is replaceable.
        3) Inspect housing for cracks or damage. Inspect bearings for damage. Inspect sector gear teeth for chipping or excessive wear. Replace components as necessary.

Reassembly

1) Install sector shaft adjusting screw and shim in sector shaft. Using feeler gauge, measure clearance between adjusting screw and bottom of sector shaft "T" slot. See Fig. 3.

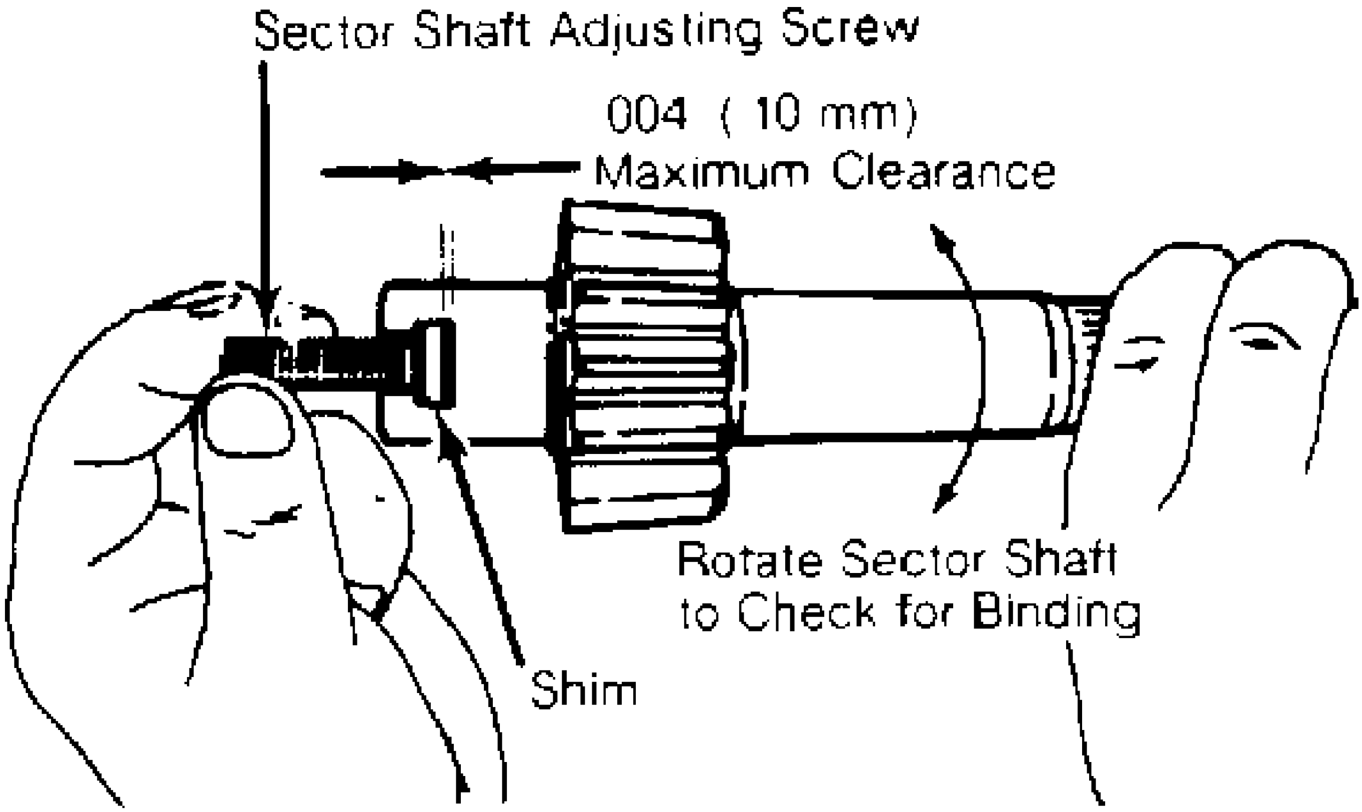


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Fig. 3: Checking Sector Shaft "T" Slot Clearance

2) Different thickness shims should be used if clearance is not within specification. See ADJUSTING SCREW CLEARANCE SPECIFICATIONS table.

ADJUSTING SCREW CLEARANCE SPECIFICATIONS TABLE

Application	In. (mm)
Cherokee, Comanche & Wrangler	.002 (.05)

3) Once correct shim is determined, install shim and adjusting screw. Hold sector adjuster screw while turning sector shaft. If sector shaft does not turn freely, increase clearance by

replacing shims as necessary.

4) Install ball nut on worm shaft. Ensure ball nut is installed so shallow end of teeth are to the left as viewed from steering wheel end of worm shaft. Align grooves in worm and nut by sighting through ball guide holes.

5) There are 2 types of ball guides used. One type contains a hole in the middle, while the other does not. If ball guides contain the middle hole, install ball guides in the ball nut.

6) Divide balls into 2 equal groups. Insert each group into a ball guide, while slowly turning worm shaft away from the hole. Repeat procedure for remaining circuit.

7) On guides with no holes, separate guide halves and fill each one half of each circuit with balls. Install remaining guide half. Hold guides and plug ends with grease to prevent the balls from falling out.

8) Fill each circuit of ball nut with half of remaining balls in one circuit, and half in other. DO NOT turn worm shaft while installing. It may be necessary to use small punch to aid in ball installation. Install ball guides. On both types, install ball guide clamp.

9) To install, reverse removal procedure. Lubricate all seals, bearings and sector shaft prior to installation. Coat worm bearing adjuster, sector shaft adjuster screw and sector shaft cover bolts with non-hardening sealant prior to installation.

10) Screw worm bearing adjuster down until nearly all end play has been removed. Lubricate steering gear by rotating worm shaft until ball nut is at end of its travel.

11) Pack as much grease as possible into steering gear housing without losing it out sector shaft opening. Rotate ball nut to other end of its travel and pack more grease into housing.

12) Rotate ball nut until it is in center of its travel. Insert sector shaft assembly, containing adjusting screw and shim into housing. Center tooth of sector gear must engage center rack tooth space in ball nut.

13) Pack housing with grease. Apply a thin bead of sealant to sector shaft cover on models which do not use gasket. Install cover and gasket on housing. Engage sector adjuster screw with tapped hole in center of sector cover by turning screw counterclockwise.

14) Turn adjusting screw until sector cover is flush with housing. Install sector cover bolts but do not tighten unless there is a lash between sector shaft and worm shaft.

15) Tighten sector cover bolts to specification. Adjust steering gear preload and meshload. See ADJUSTMENTS in this article.

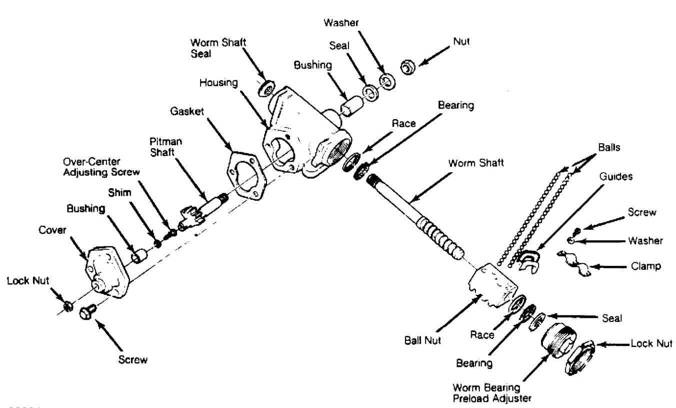


Fig. 4: Exploded View of Saginaw Model 525 Steering Gear (Typical)

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS TABLE

Application	Ft. Lbs. (N.m)
Adjuster Screw Lock Nut	25 (34)
Flex Coupling Pinch Bolt	45 (61)
Sector Shaft Nut	185 (252)
Sector Cover Bolt	32 (43)
Steering Gear-to-Frame Bolt	75 (102)
Worm Bearing Adjuster Lock Nut	50 (68)

1987-88 STEERING
Jeep Power Steering Gears - Saginaw Rotary Valve

Cherokee, Comanche, Grand Wagoneer, Pickup, Wagoneer, Wrangler

DESCRIPTION

Steering gear is a recirculating ball-type, available in either a constant or a variable ratio design. Steel balls form a "rolling thread" between steering gear worm shaft and rack/piston nut. Worm shaft thrust is absorbed by a thrust bearing and two races at lower end, and by a bearing in adjuster plug at upper end.

This design puts spring pressure on worm shaft to ensure proper thrust bearing preload. Adjuster plug provides initial preload adjustment and service adjustment (when repairing gear). As worm shaft is turned right, rack/piston is moved upward in gear.

As worm shaft is turned left, rack/piston is moved downward in gear. The rack/piston teeth mesh with sector, which is forged as part of sector shaft. Rotating worm shaft moves sector shaft, which turns wheels through mechanical linkage. See Fig. 1.

TROUBLE SHOOTING

Refer to TROUBLE SHOOTING - BASIC PROCEDURES article in the GENERAL TROUBLE SHOOTING section.

LUBRICATION

See POWER STEERING GENERAL SERVICING article.

TESTING

See POWER STEERING GENERAL SERVICING article.

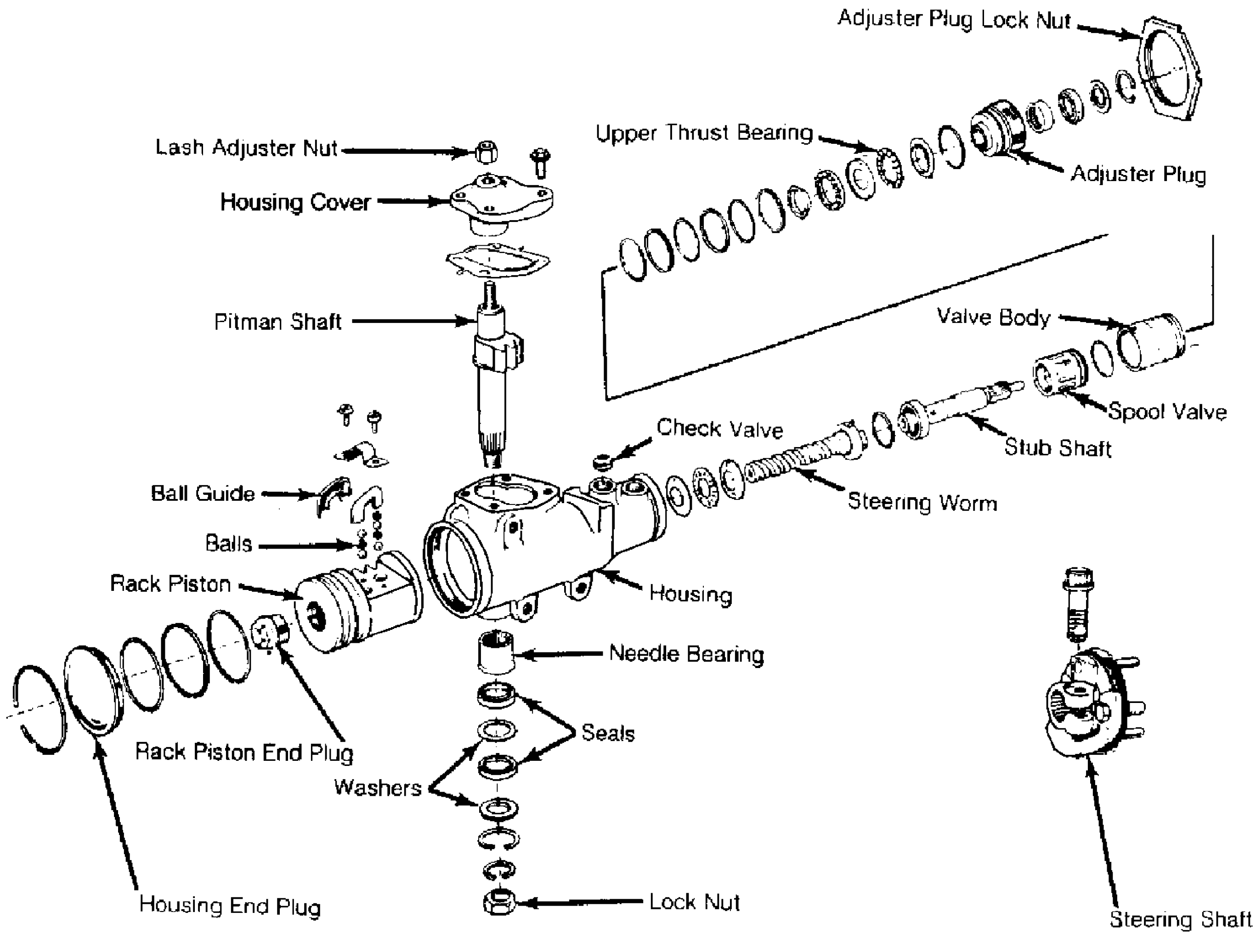


Fig. 1: Exploded View of Saginaw Rotary Valve Power Steering Gear

ADJUSTMENTS

THRUST BEARING PRELOAD ADJUSTMENT

1) Remove steering gear from vehicle. Remove adjuster plug lock nut. Turn adjuster plug clockwise with a spanner wrench until plug is seated in housing. This will require 20-30 ft. lbs. (27-41 N. m) of torque.

2) Place an index mark on housing opposite one spanner wrench hole in adjuster plug. Measure 1/2" (13 mm) counterclockwise from mark and again mark housing. Rotate plug counterclockwise until hole in adjuster lines up with second mark.

3) Tighten lock nut. Ensure adjuster remains in position. Attach an INCH lb. torque wrench to end of input shaft. Turn input shaft to right stop, then back 1/4 turn.

4) Using torque wrench measure rotational torque required to turn shaft. Reading should be taken with beam of torque wrench near vertical while turning it counterclockwise at an even rate. Torque reading should be 4-10 INCH lbs. (.4-1.1 N.m). See. Fig. 2.

NOTE: If reading does not fall within this range, adjuster plug may have turned while lock nut was being tightened. Steering gear may be incorrectly assembled or worm shaft thrust bearings and races may be defective. Repair as required and readjust preload.

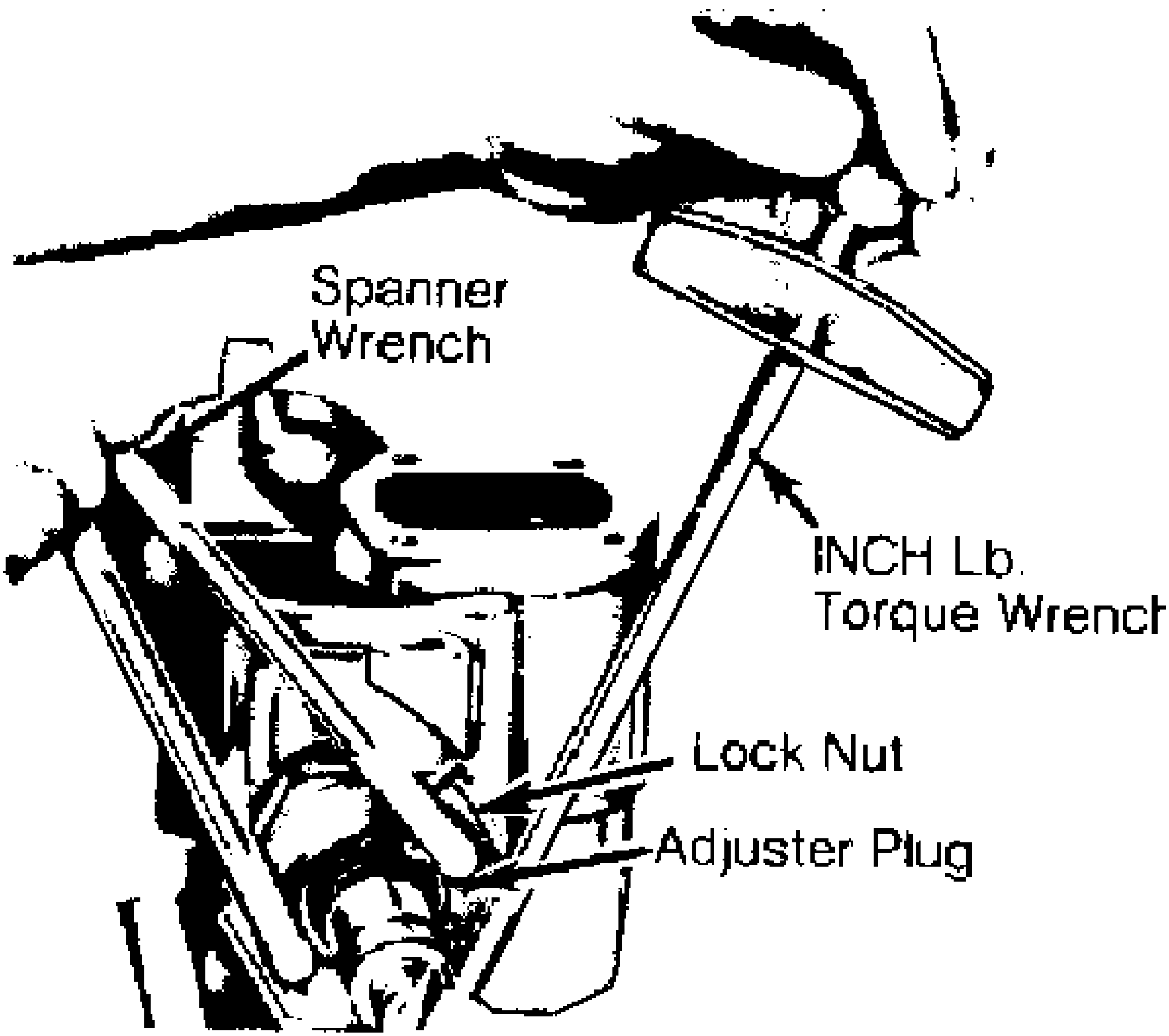


Fig. 2: Measuring Thrust Bearing Preload

OVER-CENTER PRELOAD TORQUE ADJUSTMENT

1) Loosen adjuster screw lock nut. Back off adjuster screw until stopped, then turn in 1 full turn. Rotate input shaft from stop to stop counting number of turns. Turn shaft half way back to center position.

2) Attach an INCH lb. torque wrench to input shaft. Turn

shaft from side to side through specified arc on each side of center. See OVER-CENTER PRELOAD chart. Note torque reading going over center. Adjust thrust bearing preload before over-center preload. See Fig. 3.

OVER-CENTER PRELOAD SPECIFICATIONS - INCH LBS. (N.m)

Application	Arc	Over-Center	(1) Total
New Gears	45°	4-8 (.4-.9)	14 (1.5)
Used Gears (2)	45°	4-5 (.5-.6)	14 (1.5)

(1) - Total preload is sum of thrust bearing and over-center preload.
(2) - In service for more than 400 miles (640 km.).

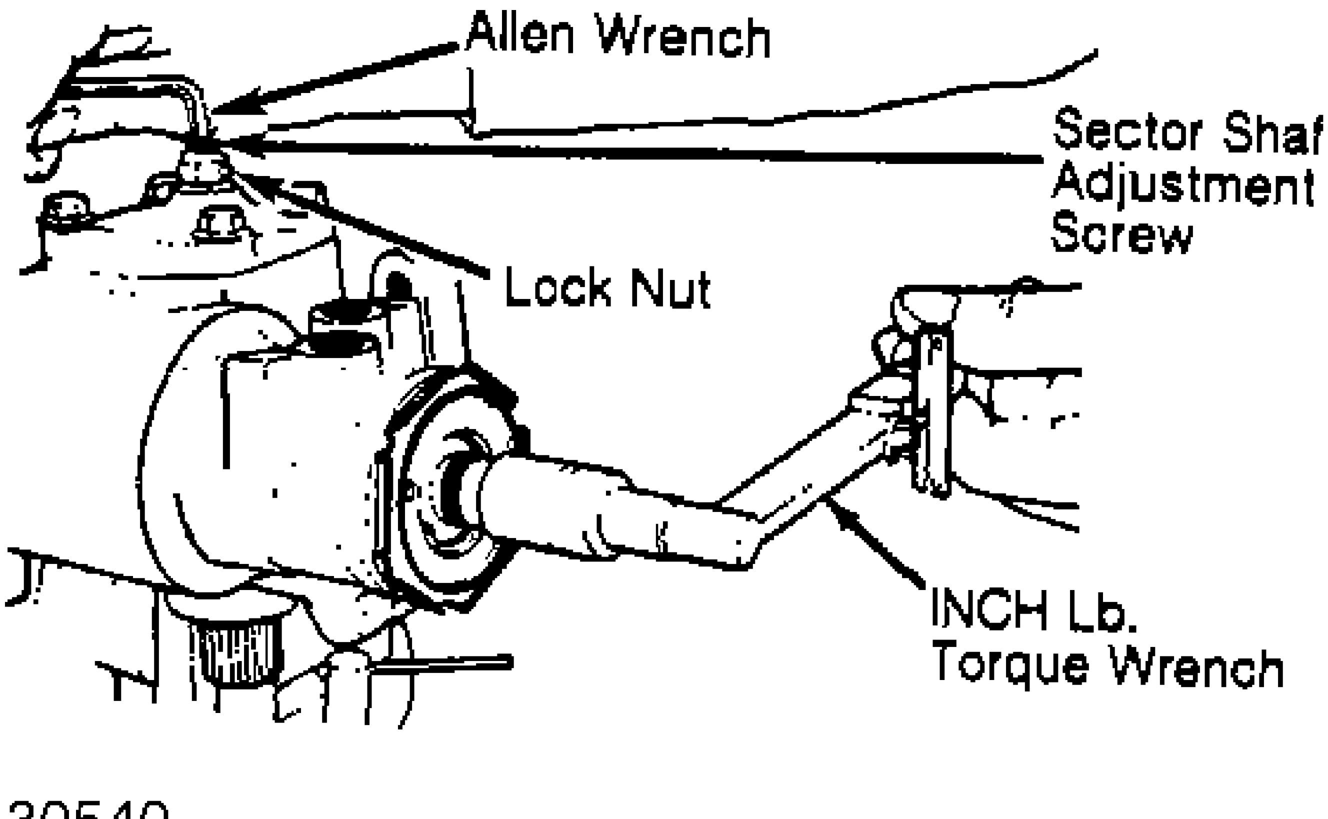


Fig. 3: Adjusting Over-Center Preload

REMOVAL & INSTALLATION

POWER STEERING PUMP

Removal & Installation

1) Loosen and remove pump drive belt. Disconnect pressure and return hoses from pump. Cap ends to prevent loss of fluid or contamination.

2) Remove bracket-to-engine bolts. Remove pump and mounting bracket as an assembly. To install, reverse removal procedure. Fill and bleed system.

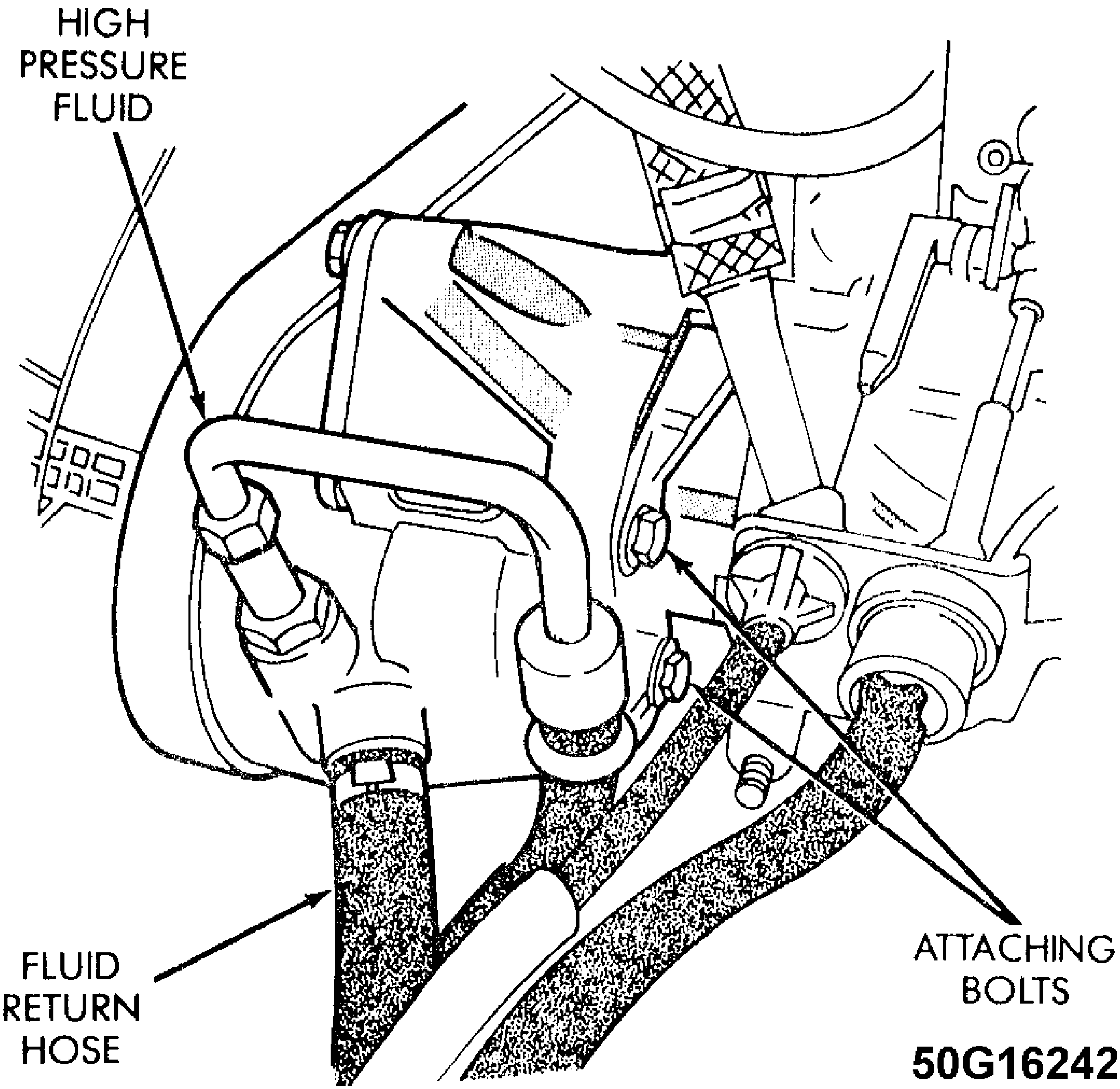


Fig. 4: Power Steering Pump (Cherokee & Commanche)

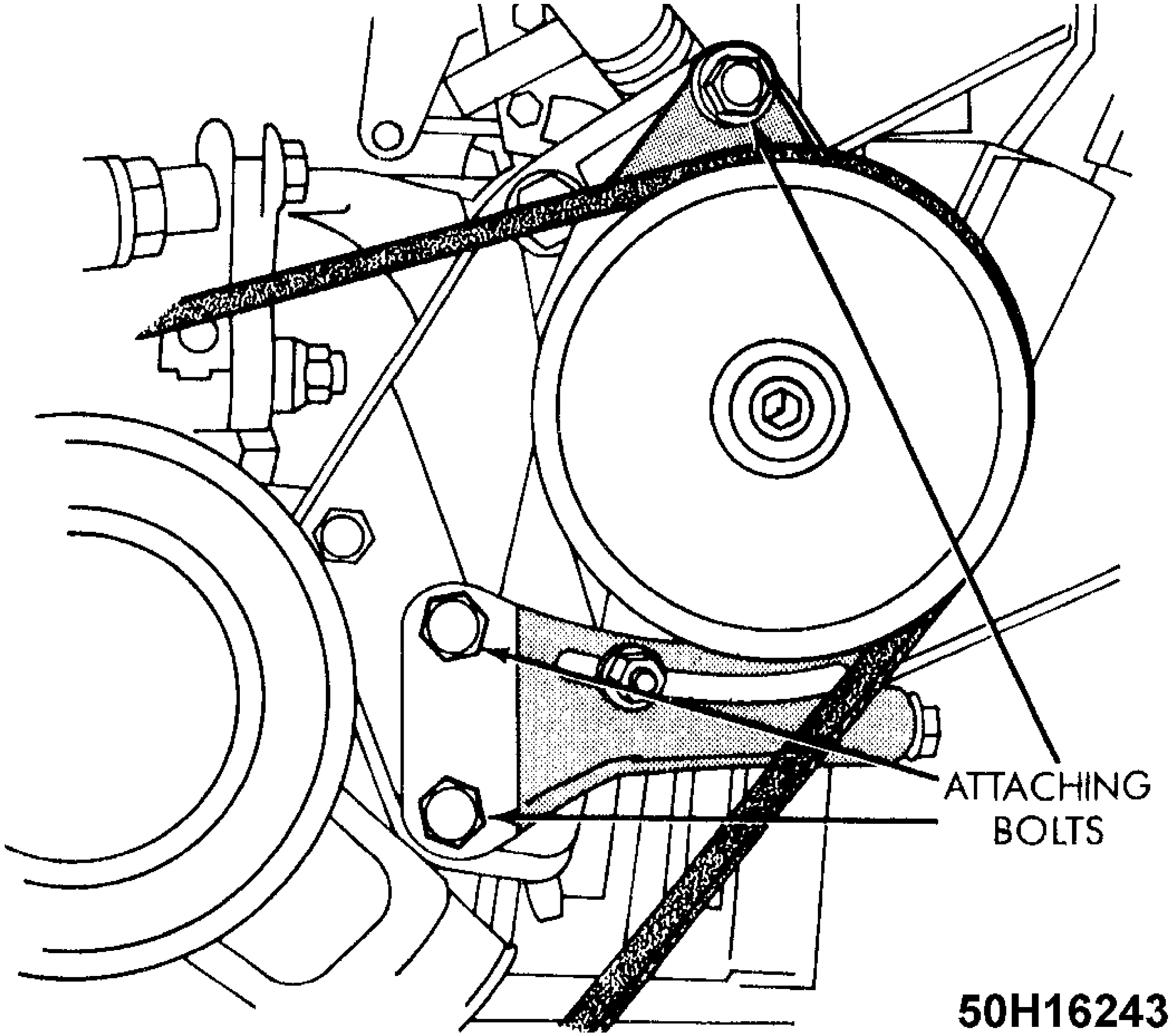


Fig. 5: Front Bracket Boltsp (Cherokee & Commanche)

STEERING GEAR

Removal

1) Remove collapsible steering column. Raise and support vehicle. Place drain pan under steering gear assembly. Center steering gear. Disconnect hydraulic hoses from gear and cap ends. Disconnect steering linkage from pitman arm. Remove pitman arm from gear.

2) Remove flexible coupling clamp bolt and bolts retaining steering gear to frame. Disconnect gear from flexible coupling and remove gear from vehicle. On Jeep CJ7 and Scrambler models, remove steering gear and mounting bracket as an assembly.

Installation

To install, reverse removal procedure. Fill pump reservoir. Bleed air from system. See POWER STEERING GENERAL SERVICING article.

OVERHAUL

SUBMERGED VANE POWER STEERING PUMP

Disassembly

1) Drain pump reservoir. Clean exterior of unit. Measure distance shaft protrudes from pulley, and record for assembly reference. Using pulley remover, remove pulley from shaft. Clamp pump in vise; DO NOT overtighten vise. Remove pressure line union, reservoir mounting stud and reservoir. See Fig. 6. Remove and discard pressure line union "O" rings.

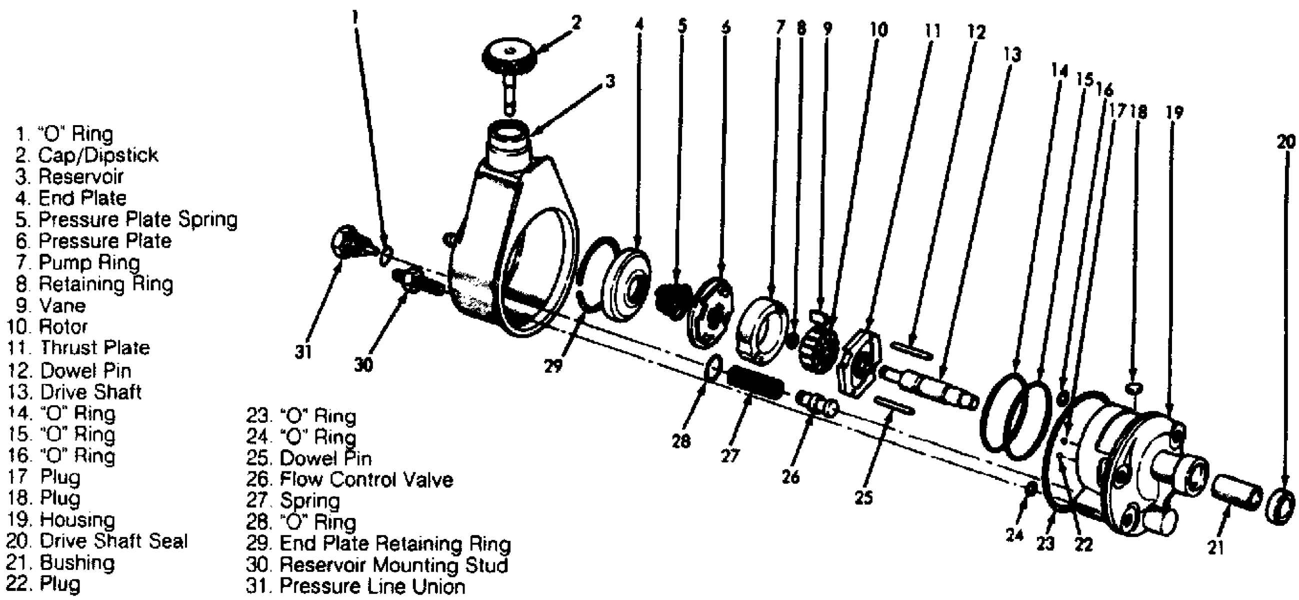


Fig. 6: Exploded View of Pump Assembly (Grand Wagoneer & Wrangler)
Courtesy of Chrysler Motors

2) Using punch and screwdriver, remove end plate retaining ring. Remove end plate and pressure plate spring. Remove "O" ring, flow control valve and spring. Note direction of pump ring installation for reassembly reference.

3) Using soft-faced hammer, tap end of drive shaft to loosen pressure plate. Remove pressure plate, pump ring, vanes, retaining ring, rotor and thrust plate assembly from body. Remove drive shaft. Using a screwdriver, pry drive shaft oil seal from housing. Remove dowel pins and seals.

Cleaning & Inspection

1) Clean all pump components in solvent, and blow dry. Inspect flow control valve assembly for wear, scoring, burrs and other damage. Inspect seal bore for burrs, nicks and score marks.

2) Inspect machined surfaces of body for scratches and burrs. Check "O" ring mating surfaces. Inspect drive shaft for excessive wear.

3) Inspect pump ring for roughness. Check thrust plate and pressure plate for scoring and wear. Ensure vanes slide freely but fit snugly into slots. If vanes are loose in slots, replace rotor and/or vanes.

Reassembly

1) Before installation, coat all "O" rings, rotor, pressure

plate and end plate with petroleum jelly. Install new drive shaft seal in housing. Install "O" ring in third groove of housing. Install dowel pins in thrust plate. Install drive shaft through thrust plate and rotor. Install NEW retaining ring. Ensure rotor slides freely on drive shaft splines.

2) Install drive shaft in pump housing. Ensure thrust plate engages with dowel pins. Install pump ring on dowel pins with rotation arrow facing upward. Install vanes with rounded edges toward pump ring.

3) Lubricate outer chamfered edge of pressure plate with petroleum jelly. Install pressure plate with spring groove facing upward. To seat pressure plate, place large socket on pressure plate and press downward approximately 1/16".

4) Install end plate "O" ring in second groove of housing. Install pressure plate spring and end plate in housing. Press end plate downward, and install retaining ring. Install "O" ring, flow control valve and spring.

5) Install mounting stud and pressure line union "O" rings in rear of pump housing. Lubricate inner edge of reservoir with petroleum jelly, and install. Install mounting stud. Tighten stud to specification. Install pressure line union, and tighten to specification. See appropriate table under TORQUE SPECIFICATIONS.

6) Using Pump Pulley Installer (J-25033-B), install pulley on pump shaft. Ensure shaft protrudes distance measured in disassembly procedure.

7) When replacing plastic pulley with metal pulley, install pulley flush with end of shaft. Install pump on engine, and compare alignment with adjacent pulleys. If necessary, correct alignment by using pump pulley installer to adjust shaft protrusion.

NON-SUBMERGED VANE POWER STEERING PUMP

Disassembly

1) Remove return tube. Clean exterior of unit. Measure distance shaft protrudes through pulley, and record for reassembly reference. Using pulley remover, remove pulley from shaft. Remove fitting, "O" ring, flow control valve and spring. See Fig. 7.

2) Remove snap ring, drive shaft and bearing. Note direction of snap ring installation for reassembly reference. Support drive shaft bearing on inner race, and press drive shaft from bearing. Using screwdriver, remove drive shaft seal from housing.

3) Insert punch into access hole to disengage and remove retaining ring. Using a brass drift, tap on thrust plate, and remove. Remove "O" ring, pump ring, rotor and vanes. Remove dowel pins, pressure plate, "O" ring and pressure plate spring. Remove "O" ring, dowel pin and sleeve.

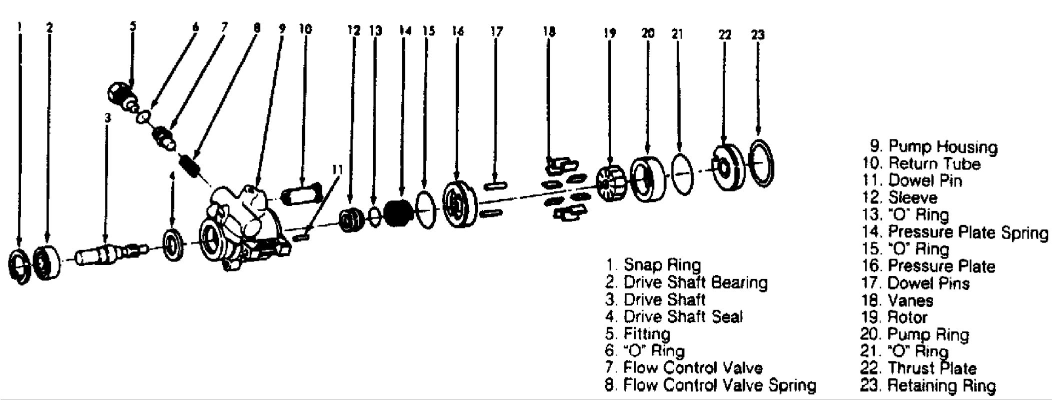


Fig. 7: Exploded View of Cherokee & Comanche Pump Assembly
Courtesy of Chrysler Motors

Cleaning & Inspection

1) Clean all pump components in solvent, and blow dry. Inspect flow control valve assembly for wear, scoring, burrs and other damage. Inspect seal bore for burrs, nicks and score marks.

2) Inspect machined surfaces of body for scratches and burrs. Check "O" ring mating surfaces. Inspect drive shaft and sleeve for wear.

3) Inspect pump ring for roughness. Check thrust plate and pressure plate for scoring and wear. Ensure vanes slide freely but fit snugly into slots. If vanes are loose in slots, replace rotor and/or vanes.

Reassembly

1) Lubricate all "O" rings, seals, pump ring, rotor and vanes with petroleum jelly. Install sleeve. Ensure sleeve is fully seated.

2) Install "O" ring in sleeve seat. Install small dowel pin in pump housing. Install pressure plate spring and "O" ring. Install pressure plate with dowel pin hole aligned with dowel pin holes. Install dowel pins.

3) Install pump ring with identification marks located adjacent to one dowel pin. Install rotor with counterbore toward drive shaft end of housing.

4) Install vanes with rounded edges toward pump ring. Install thrust plate "O" ring. Install thrust plate with indentations aligned with bolt holes of housing. Install retaining ring.

CAUTION: Pump ring must be installed with identification marks located adjacent to dowel pins. Thrust plate must be installed so indentations in thrust plate align with bolt holes of housing and thrust plate engages with pump ring dowel pins.

5) Using a socket, install drive shaft seal in housing until seal bottoms. Support drive shaft bearing on inner race, and press drive shaft into bearing. Install drive shaft and bearing in pump housing.

6) Rotate drive shaft during installation to align with rotor serrations. Ensure bearing is fully seated in pump housing. Snap ring should be installed with large lug area (near snap ring pliers hole) positioned right of small lug (near snap ring pliers hole), ensuring beveled area of snap ring is properly positioned.

7) Install spring, flow control valve and "O" rings. Install return tube with new "O" ring. Install pulley.

STEERING GEAR

Disassembly

1) Cap all openings in gear. Clean gear exterior thoroughly. Mount gear in vise so that pitman shaft points downward. Rotate housing end plug retainer ring until one end of plug is over the hole in the housing.

2) Force end of ring from groove in housing and remove. Rotate input shaft counterclockwise to force housing end plug out of housing. Rotate input shaft clockwise 1/2 turn to draw rack/piston inward. Remove piston end plug.

CAUTION: DO NOT rotate shaft more than is necessary to remove plug as ball bearings will fall out of worm and rack piston assembly.

3) Remove lock nut from sector shaft adjuster. Remove sector shaft cover. Remove and discard "O" ring from cover. Turn input shaft until sector shaft teeth are centered in housing.

4) Tap end of sector shaft with a soft-faced hammer to free shaft from housing, then remove sector shaft. Remove adjuster plug lock nut. Remove adjuster plug with a spanner wrench.

5) Insert a rack/piston arbor into end of rack/piston until arbor just contacts worm shaft. Turn stub shaft counterclockwise to force rack/piston onto arbor. Remove rack/piston and arbor as an assembly.

6) Take care to keep arbor fully inserted so ball bearings will not fall out. Remove input shaft and control valve assembly from housing. Remove worm, wormshaft lower thrust bearing, and races from housing.

Reassembly

1) Lubricate all parts with clean power steering fluid before reassembly. Install the lower thrust bearing and races onto the worm. Cupped side of thrust washers must face toward stub shaft. See Fig. 8.

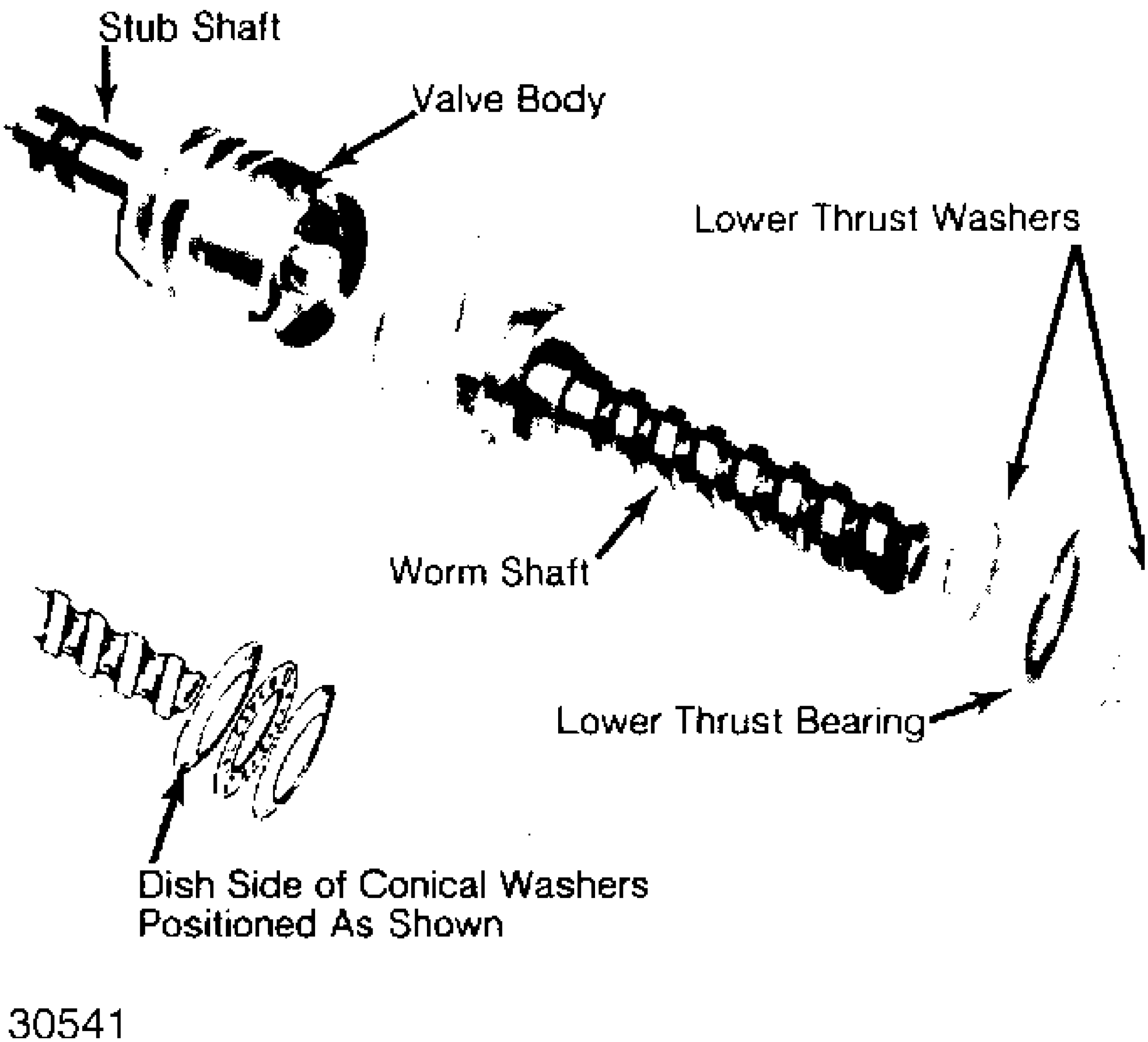


Fig. 8: Reassembly of Valve Body & Worm Shaft Assembly

NOTE: If conical thrust races are used, ensure tapered surfaces are parallel to each other and that cupped sides face toward stub shaft.

2) Install stub shaft cap "O" ring in valve body. Align valve body drive pin on worm with narrow pin slot in valve body. Worm drive lugs must engage in stub shaft cap.

3) Install valve body and worm assembly into housing. Perform installation by pressing directly on valve body only. This will prevent stub shaft "O" ring from disengaging from valve body.

4) Valve body is correctly seated when fluid return port in housing is fully visible. Ensure worm locating pin is fully engaged in valve body. Place seal protector over input shaft, install a new adjuster plug "O" ring, then install adjuster plug.

5) Remove seal protector from housing and loosely install adjuster plug lock nut. Insert arbor and rack/piston into housing. Align worm and rack/piston and turn stub shaft clockwise to engage worm. Maintain pressure on arbor until worm is fully engaged.

6) Turn input shaft clockwise until middle rack groove in rack/piston is aligned with center of sector shaft roller bearing. Remove arbor. Install a new sector shaft cover gasket.

7) Thread sector shaft cover onto adjuster screw until bottomed. Back off 1 1/2 turns. Install sector shaft so that center gear tooth meshes with center groove in rack/piston. Install cover attaching bolts.

8) Install adjuster lock nut halfway onto sector shaft. Install piston and plug in rack/piston. Install housing end plug "O" ring, end plug and retainer ring. Adjust worm bearing preload and over-center preload at this time.

ADJUSTER PLUG

Disassembly

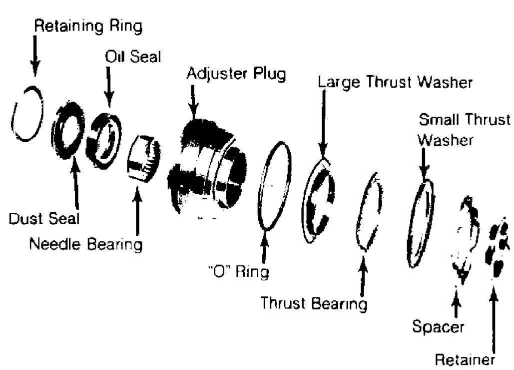
1) Remove thrust bearing retainer ring with a screwdriver, taking care not to score needle bearing bore. Discard retainer ring. Remove thrust bearing spacer, thrust bearing and bearing races.

2) Remove and discard adjuster plug "O" ring, then remove input shaft seal retainer. Remove and discard dust seal. Pry input shaft seal from adjuster plug.

3) Inspect needle bearing in adjuster plug. If necessary, remove bearing by pressing out from spacer end. See Fig. 9.

Inspection

Inspect thrust bearing for cracks and rollers for pitting, scoring, or cracking. Check thrust races and spacer for damage or damage. Replace parts as necessary.



30542

Fig. 9: Exploded View of Adjuster Plug Assembly

Reassembly

1) Press roller bearing into adjuster plug (identification end facing arbor) until bearing bottoms on input shaft seal bore.

Install input shaft seal with spring in seal facing adjuster plug.

2) Install dust seal into adjuster plug. Rubber face of seal must face away from plug. Install retainer ring. Install adjuster plug "O" ring.

3) Assemble thrust bearing, thrust bearing race, and thrust bearing spacer on adjuster plug. Using a brass or wooden dowel, press bearing retainer into needle bearing bore.

RACK/PISTON & WORM

Disassembly

Remove worm, lower thrust bearing and bearing races from rack piston. Remove piston ring and back-up "O" ring from rack/piston. Remove ball return guide clamp, ball return guide and all ball bearings from rack/piston.

Inspection

1) Clean and dry all parts. Inspect worm and rack/piston grooves for scoring. Inspect ball bearings for damage. If any ball bearings are damaged, replace entire set. Check ball guides for pinching of ends.

2) Inspect lower thrust bearing races for cracking, scoring, or pitting. Replace wormshaft and rack/piston as an assembly if either part is damaged. Inspect rack/piston teeth for chips, cracks, dents or scoring.

Reassembly

1) Install "O" ring and piston ring onto rack/piston using care not to twist them. Install worm into rack/piston until worm is against piston shoulder. Install ball bearings into rack/piston while slowly rotating worm counterclockwise.

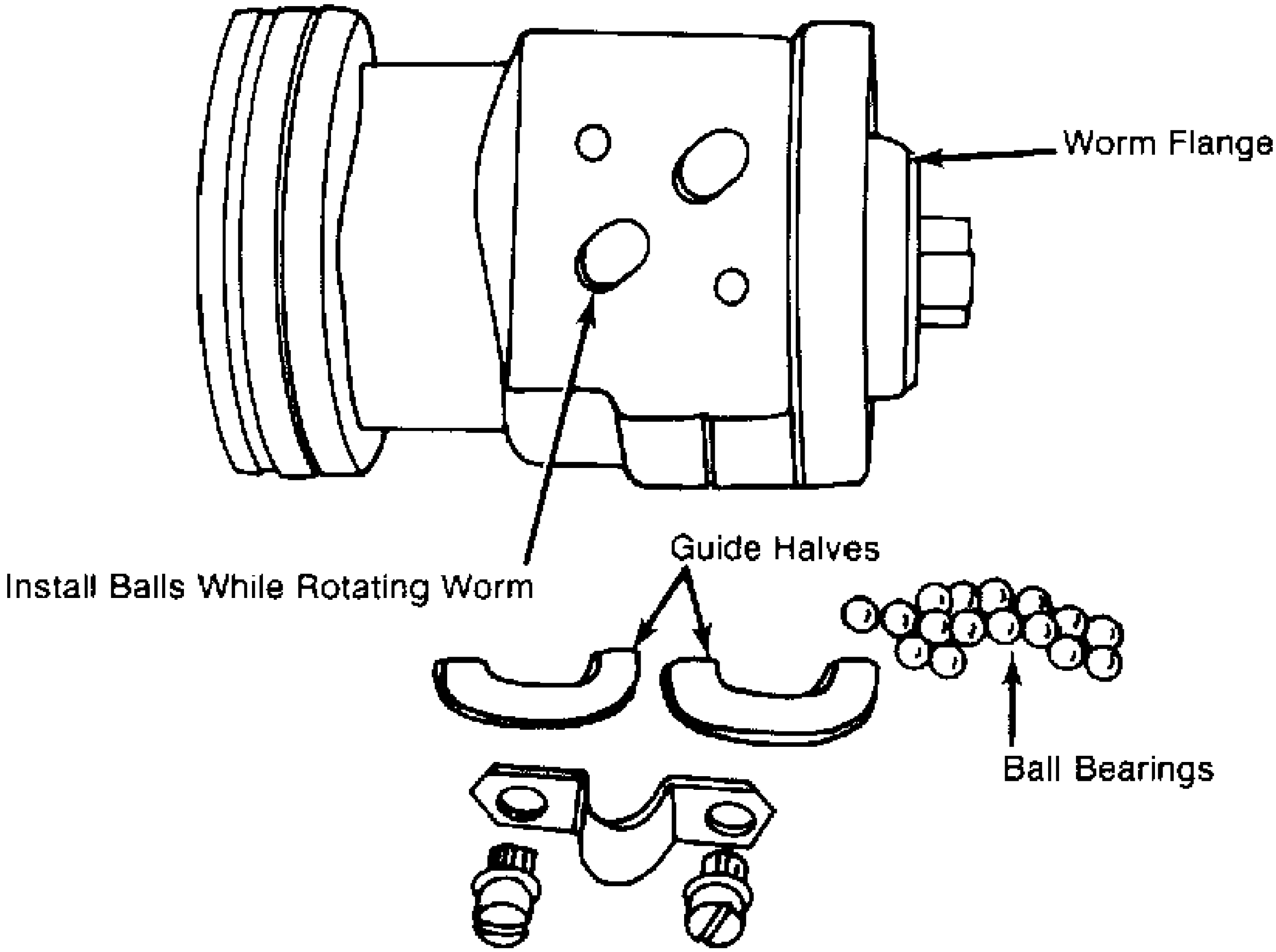
NOTE: See RACK PISTON & WORM ASSEMBLY BALL BEARINGS table for number of balls to be installed. BE SURE to install light and dark colored balls alternately, as Black balls are .0005" smaller than Silver balls.

2) Install correct number of balls in ball guide. Bearings in guide must be in sequence with bearings in rack/piston. Hold balls in place with chassis lubricant and install return ball guide assembly into position.

3) Install clamp and tighten attaching bolts. Alternate light and dark colored balls when installing. See Fig. 10. Insert rack/piston arbor into rack/piston until it contacts worm. Maintain pressure on arbor, and back worm out of rack/piston. DO NOT allow ball bearings to drop out of circuits.

RACK PISTON & WORM ASSEMBLY BALL BEARINGS TABLE

Application	Rack/Piston	Guide
Jeep	18	6



30543
Fig. 10: Installing Ball Bearing into Rack/Piston Assembly

ROTARY VALVE

NOTE: Complete valve assembly is balanced during assembly. If replacement of any part other than rings or seals is necessary, replace complete assembly.

Disassembly

1) Remove and discard stub shaft cap "O" ring. Invert valve and lightly tap end of stub shaft against wood block until shaft cap is free of valve body. Pull stub shaft outward until drive pin hole is visible. Depress the pin to remove the stub shaft from the valve body. See Fig. 11.

NOTE: DO NOT pull shaft any further than 1/4" (6 mm) or spool valve may become cocked in valve body.

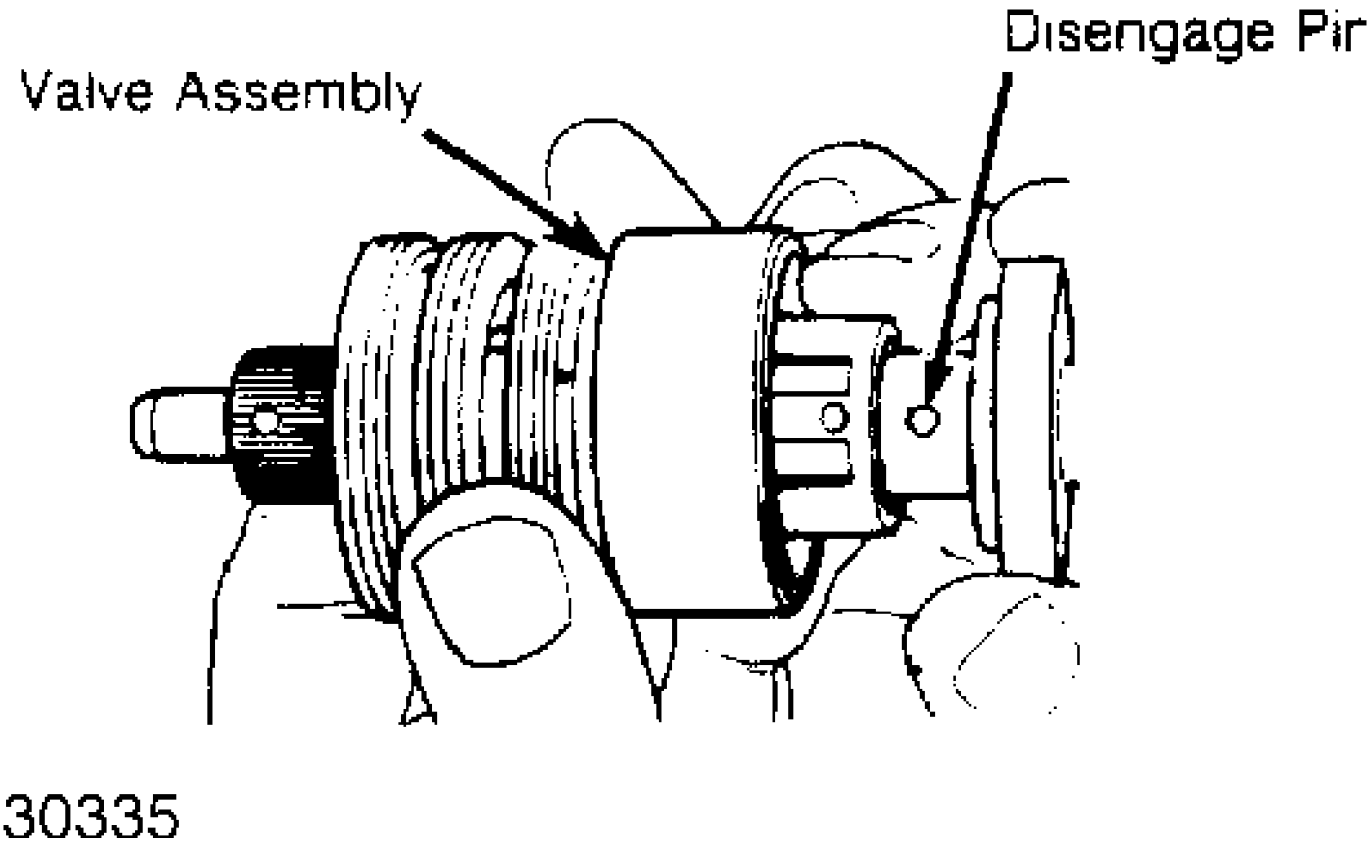


Fig. 11: Pulling Shaft from Valve Assembly

2) Disengage drive pin and carefully remove stub shaft from valve body and spool assembly with a twisting motion. If binding occurs, realign valve and try removal again.

CAUTION: DO NOT force stub shaft or spool out of valve body.

3) Remove spool valve from valve body with twisting motion. Remove and discard all "O" rings and Teflon rings.

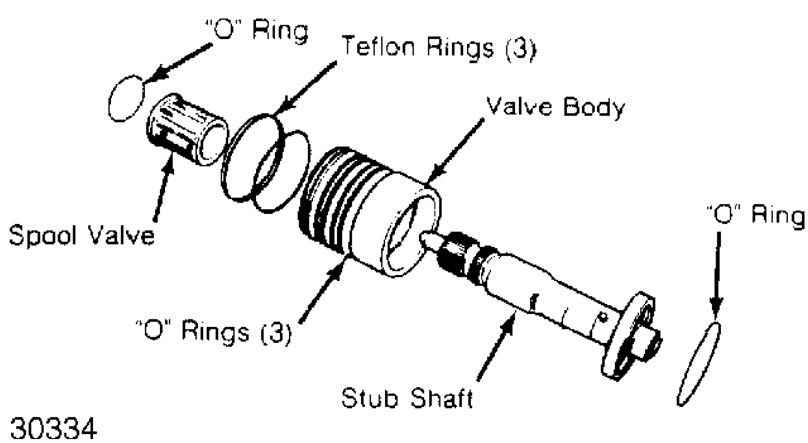


Fig. 12: Exploded View of Valve Body Assembly

Reassembly

1) Lubricate all valve body components with power steering fluid. Install replacement back-up "O" rings in seal grooves and

install replacement seal rings over back-up rings. Take care not to damage seal rings during installation.

NOTE: Teflon seal rings may appear to be distorted after installation. However, heat of operation will straighten them.

2) Lubricate replacement spool valve damper "O" ring with petroleum jelly. Install on spool valve. Carefully insert spool valve into valve body.

3) Push spool valve through valve body until locating pin hole is visible at opposite end of valve body and spool valve is flush with the notched end of the valve. Install stub shaft in spool valve and valve body.

4) Be sure stub shaft locating pin is aligned with spool valve locating hole. Align notch in stub shaft cap with stub shaft locating pin and press sub shaft and spool valve into valve body. Install stub shaft cap "O" ring into valve body. See Fig. 13.

CAUTION: Before installing assembled valve body into gear housing, be sure valve body stub shaft locating pin is fully engaged in stub shaft cap notch. DO NOT allow stub shaft to disengage from valve body pin.

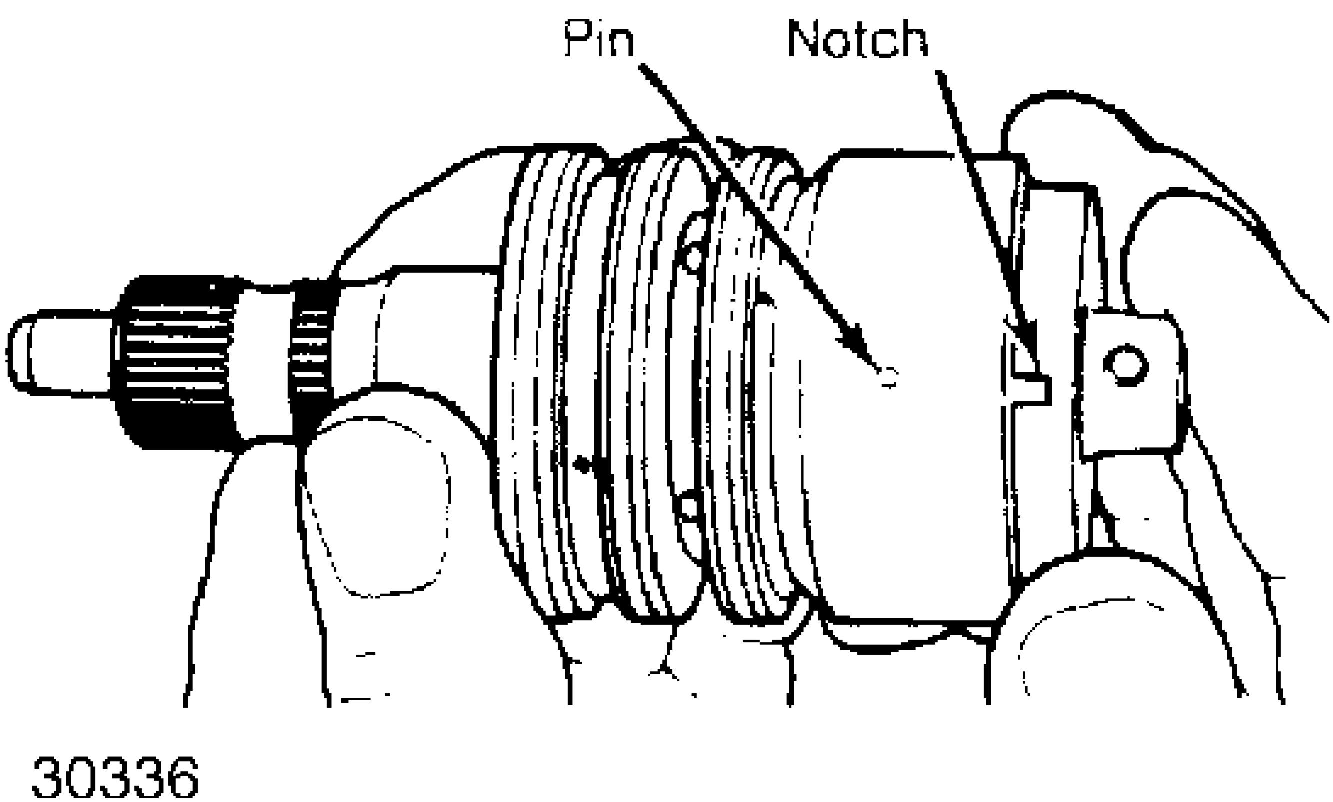


Fig. 13: Aligning Pin & Notch for Input (Stub) Shaft
Stub shaft locating pin must align with spool valve locating hole.

STEERING GEAR HOUSING

Disassembly

1) Remove sector shaft seal retaining ring and remove lower steel washer. Remove lower seal, spacer washer and upper seal from housing. Press sector shaft bearing out of housing from lower end.

2) To remove hose connector seat, tap out seat using a 5/16"-

18 thread tap. Thread connector seats ONLY 2-3 threads. Install a bolt with a flat washer and nut into seat.

3) Hold bolt from turning and tighten nut to extract seat from housing. Some steering gear units have metric thread fittings and hose fittings which use "O" ring seals instead of connector seats. Remove check valve and spring from inlet port and discard.

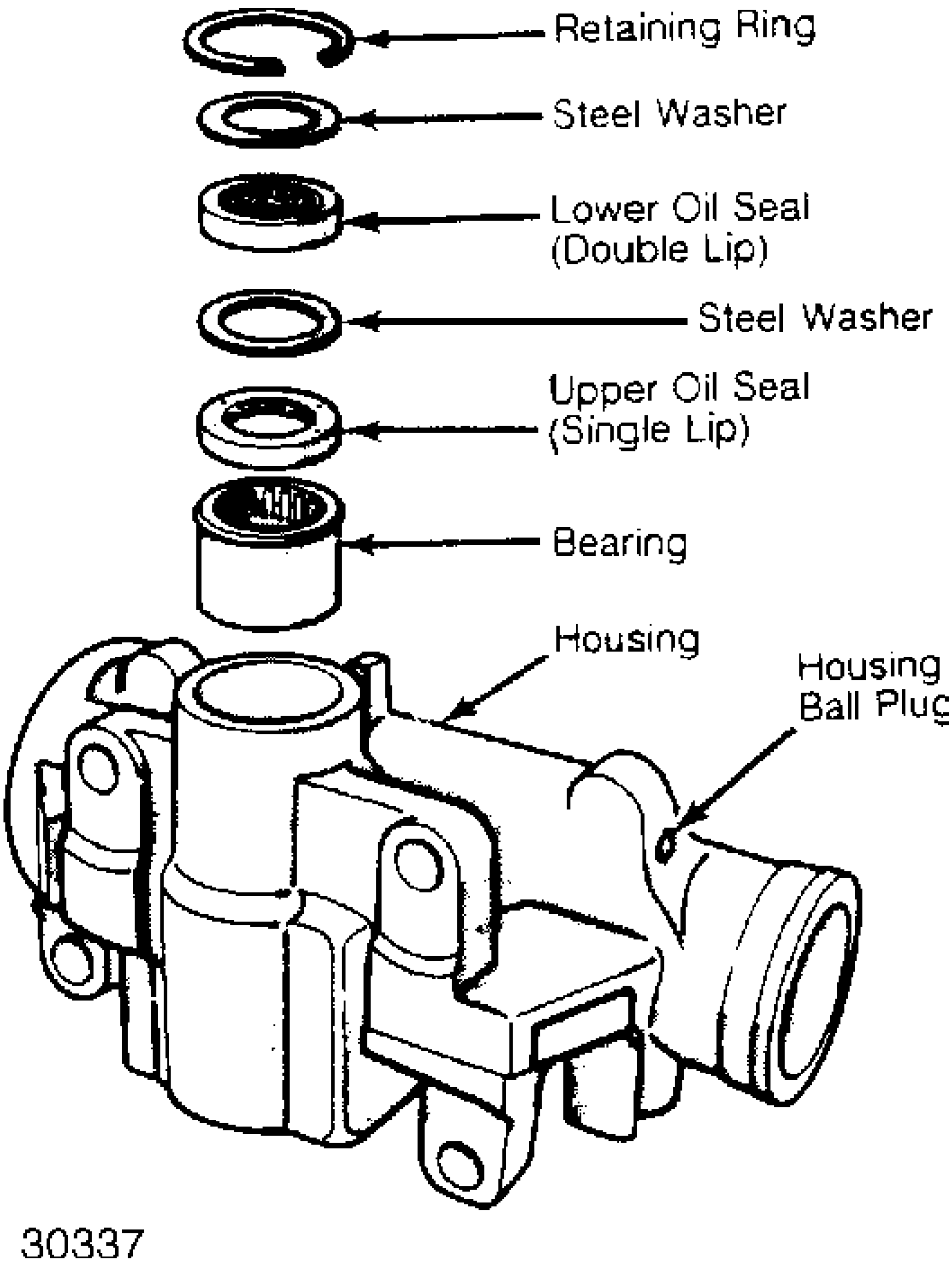


Fig. 14: Gear Housing Seals & Bearing

Inspection

1) Replace housing if bore is severely worn, scored or pitted. Minor scratches may be removed with crocus cloth. Inspect

housing ball plug for fluid leakage. Seat ball plug with blunt punch.

2) Spray ball area with Loctite Solvent 7559 and dry with compressed air. Cover ball area with Loctite Sealant 290. Allow sealant to cure for 2 hours before assembling gear.

3) Inspect all retaining ring, bearing and seal surfaces in housing. Replace housing if any surface is worn or damaged.

Reassembly

1) Working from upper end, press a new bearing into housing until it is seated .030" (.76 mm) below shoulder in housing bore. Lubricate new seal with power steering fluid.

2) Install single lipped seal and spacer washer only far enough to provide clearance for next seal, washer and retaining ring. DO NOT bottom seal against housing counterbore.

3) Install double lipped seal and steel washer. Install retaining ring. DO NOT allow seals to contact one another. To ensure proper seal action, be sure there is clearance between them.

4) If port seat was removed, position new spring, check valve, and a new seat over opening in housing. Drive into place using a brass drift.

TORQUE SPECIFICATIONS

CHEROKEE, COMANCHE, WAGONEER & WRANGLER

TORQUE SPECIFICATIONS (CHEROKEE, COMANCHE, WAGONEER & WRANGLER)

Application	Ft. Lbs. (N.m)
Adjuster Plug Lock Nut	80 (108)
Gear Housing-to-Frame Attaching Bolts	75 (102)
Pitman Arm Attaching Nut	185 (250)
Rack Piston End Plug	50 (68)
Sector Shaft Adjuster Lock Nut	33 (45)
Side Cover Bolts	45 (60)

GRAND WAGONEER & "J" TRUCK)

TORQUE SPECIFICATIONS (GRAND WAGONEER & "J" TRUCK)

Application	Ft. Lbs. (N.m)
Adjuster Plug Lock Nut	85 (116)
Gear Housing-to-Frame Attaching Bolts	(95)
Pitman Arm Attaching Nut	185 (250)
Rack Piston End Plug	75 (102)
Sector Shaft Adjuster Lock Nut	33 (45)
Side Cover Bolts	40 (54)

STEERING KNUCKLES - 4WD

1988 Jeep Cherokee

1988 4WD Steering Knuckles
ALL MANUFACTURERS

DESCRIPTION

Open type steering knuckles are used on all models. Open type knuckles provide sharper turning angle, which will decrease vehicle turning radius. Axle shafts are free floating. Depending upon vehicle model, steering knuckles can be attached to axle housing by either ball joints or roller bearings and king (pivot) pins.

OVERHAUL

BALL JOINT TYPE

Disassembly

1) Raise vehicle and support securely. Remove wheels. Remove brake caliper and rotor. If equipped, remove locking hubs. See appropriate LOCKING HUBS article in DRIVE AXLE section.

2) Disconnect tie rod end from steering knuckle. Remove spindle nuts and lightly tap spindle with soft face hammer to free it from steering knuckle. Pull out axle shaft assembly.

3) Clean all components with solvent and dry with compressed air. Inspect all parts for burrs, chips, wear, flat spots or cracks. Replace all damaged or worn parts.

NOTE: When aligning upper ball joint nut to install cotter pin, always tighten nut to align. Never loosen nut to align holes.

Reassembly

To reassemble, reverse disassembly procedure. Torque all fittings to specifications.

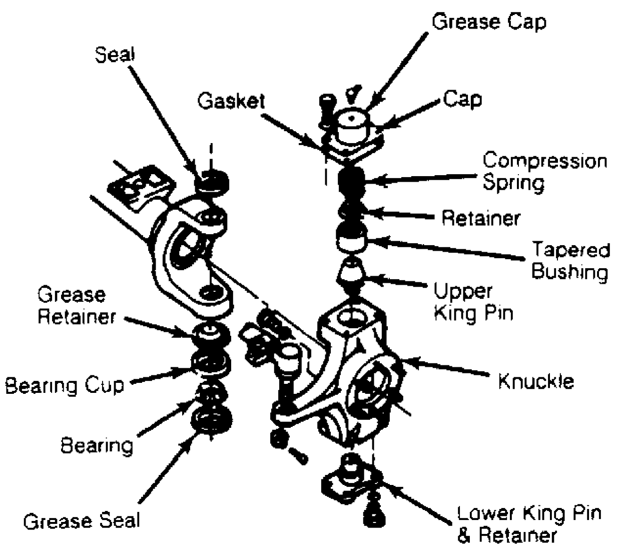


Fig. 1: Exploded View of Steering Knuckle Assembly

ADJUSTMENT

NOTE: All other models are not adjustable.

BALL JOINTS

Jeep, Truck & Wagoneer

1) Raise vehicle and remove front wheels. Disconnect steering damper and connecting rod. Remove cotter pin from right side tie rod retaining nut. Rotate steering knuckles through complete arc several times.

2) Place torque wrench on right side tie rod retaining nut. Torque to turn knuckles through complete arc should not be more than 25 ft. lbs. (34 N.m).

3) If turning effort is excessive, disconnect tie rod ends at knuckles. Measure turning effort of right and left side knuckles. Individual turning effort should not be more than 10 ft. lbs. (14 N.m).

4) If individual turning effort is more than specified, replace upper ball joint split ring seat. If turning effort is more than 10 ft. lbs. (14 N.m) after split ring seat replacement, ball joints will have to be replaced.

TURNING ANGLE

Truck & Wagoneer

1) Turning angle stop screws are located at rear of steering knuckle, just above axle centerline. To adjust, loosen lock nut on turning angle stop screw. Jeep turning angle is not adjustable.

2) Using turntable to measure angle, adjust stop screw to obtain specified angle. Tighten lock nut without changing setting.

TURN ANGLE ADJUSTMENT

TURNING ANGLE ADJUSTMENT TABLE

Application	Left Wheel	Right Wheel
Jeep		
Cherokee, Comanche, & Wrangler	(1) 32-33°	(1) 32-33°
Wagoneer	36-37°	36-37°

(1) - Angle stops are not adjustable. Parts must be replaced if angle is incorrect.

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS TABLE

Application	Ft. Lbs.(N.m)
Ball Joint Type	
Lower Ball Joint Nut	
Jeep	100 (136)
Upper Ball Joint Nut	
Jeep	100 (136)
Upper Ball Joint Split Retaining Seat	
Jeep	50 (68)

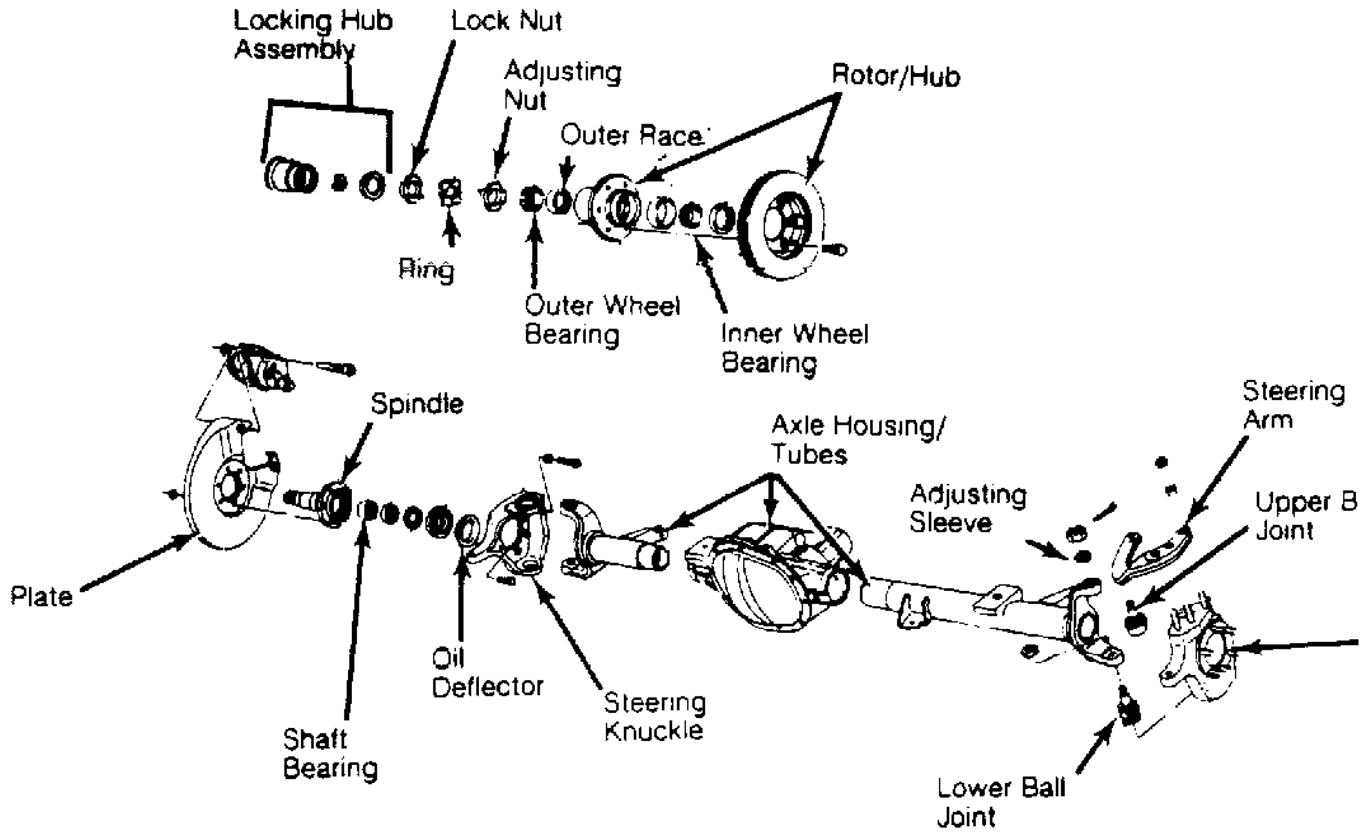


Fig. 2: Exploded View of Ball Joint Type Steering Knuckle Assembly

STEERING LINKAGE

1988 Jeep Cherokee

1988 STEERING
Jeep Steering Linkage

All Models

STEERING SERVICE PRECAUTIONS

All steering component fasteners are made of special quality materials. Replacement fasteners must be of same part number or equivalent. Tighten all fasteners to specification. Always use new cotter pins. DO NOT back off castle nuts to align cotter pin hole. Tighten nut to next slot that lines up with hole.

DO NOT hammer on ball studs. If threads are not clean and smooth, ball studs may turn in joint when nuts are tightened. Sleeve clamps must always be positioned as specified before tightening bolts.

TROUBLE SHOOTING

Refer to TROUBLE SHOOTING - BASIC PROCEDURES article in the GENERAL TROUBLE SHOOTING section.

REMOVAL & INSTALLATION

TIE ROD REPLACEMENT

Removal & Installation

1) Remove cotter pins and retaining nuts at both ends of tie rod and connecting rod ball joints. Disconnect steering damper from tie rod. Using puller and appropriate adapters from Ball Joint Tool Kit (J-34503), remove tie rod ends from steering arms and connecting rod.

2) Loosen clamp bolts. Remove tie rod ends from adjusting sleeve noting the number of turns. To install, thread new tie rod ends into adjusting sleeve. Attach tie rod ends to steering arms and connecting rod. Tighten nuts.

3) Install new cotter pins. Attach steering damper. Check and adjust toe-in. See WHEEL ALIGNMENT SPECIFICATIONS & PROCEDURES article in WHEEL ALIGNMENT section. Tighten clamp bolts.

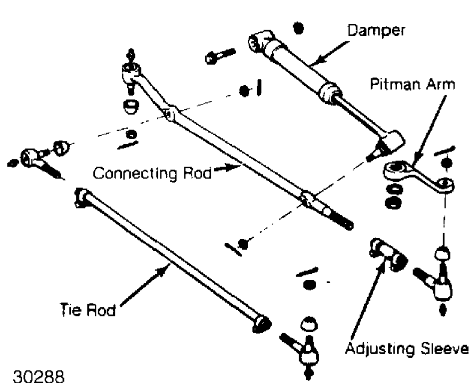


Fig. 1: Cherokee, Comanche, Wagoneer & Wrangler Steering Linkage

STEERING DAMPER REPLACEMENT

Removal & Installation

1) Place front wheels in straight-ahead position. Remove lock nuts and washers from damper ends. Remove damper assembly and rubber bushings.

2) To install, place rubber bushings in damper eyelets. On Grand Wagoneer models, secure eyelet at push rod end to stud on tie rod bracket. Install rubber bushings in damper body eyelet. On Cherokee, Comanche, Wagoneer and Wrangler, install stud at push rod end into hole on tie rod.

3) On all models, attach opposite end of damper with bolt and lock nut (Cherokee, Comanche, Wagoneer and Wrangler) or with a lock nut (Grand Wagoneer). Tighten lock nuts.

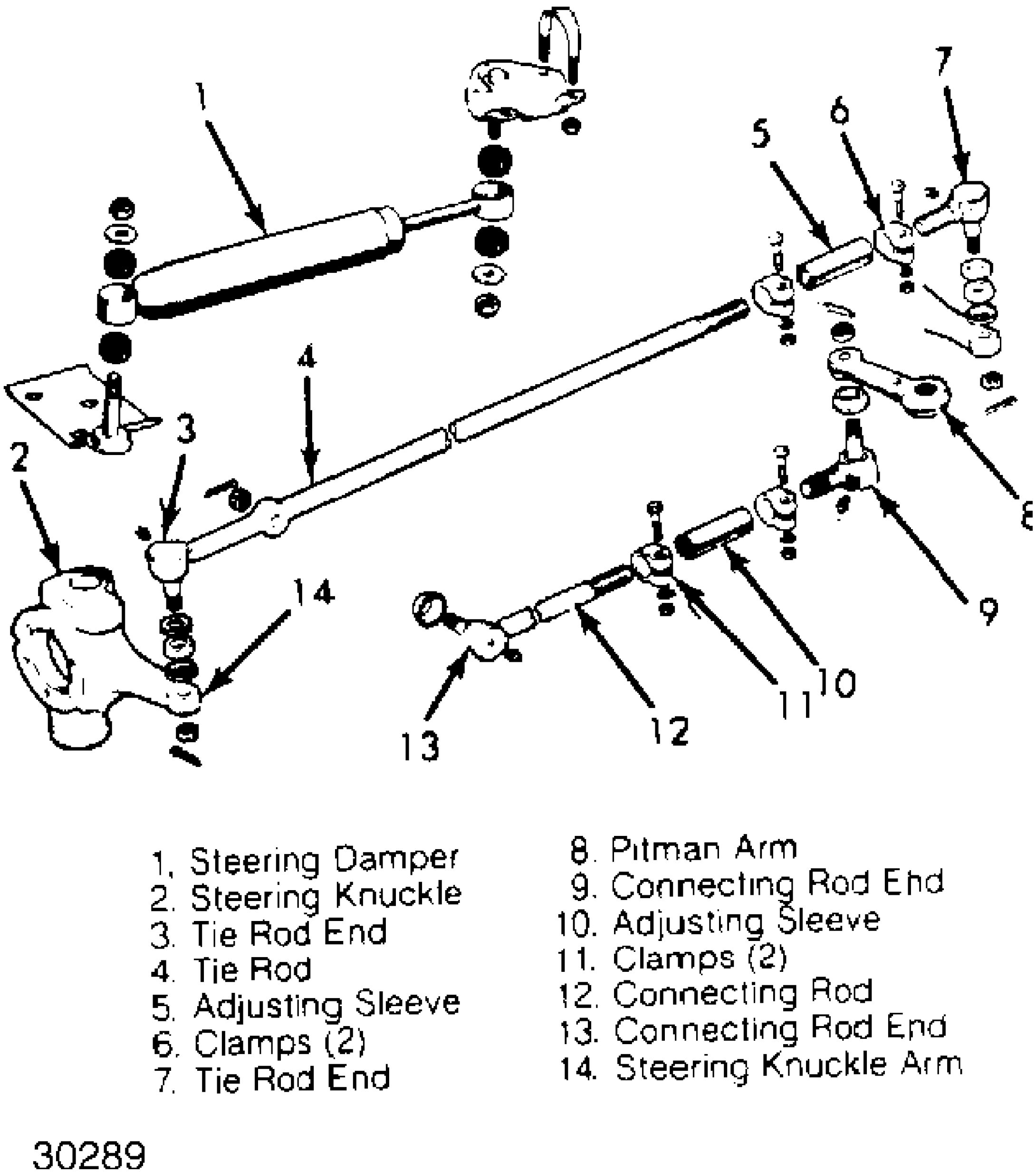


Fig. 2: Grand Wagoneer Steering Linkage

WHEEL ALIGNMENT

After performing appropriate service procedures, refer to WHEEL ALIGNMENT SPECIFICATIONS & PROCEDURES article in the WHEEL ALIGNMENT section.

CONNECTING ROD REPLACEMENT

Removal & Installation

Remove cotter pins and nuts from both ends of connecting rod. Using a separator, remove connecting rod. To install, place wheels in straight-ahead position. Center pitman arm. Install connecting rod. Tighten lock nuts. Install new cotter pins.

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS TABLE

Application	Ft.Lbs. (N.m)
Clamp Bolt	
Grand Wagoneer	30 (41)
All Others	14 (19)
Connecting Rod Nut	
5/8"	70 (95)
9/16"	60 (82)
Pitman Arm-to-Shaft Nut	185 (251)
Steering Damper Lock Nut	
Wrangler	53 (71)
All Others	30 (41)
Tie Rod End Stud Nuts	
Grand Wagoneer	60 (82)
All Others	35 (47)

* STEERING UNIFORM INSPECTION GUIDELINES *

1988 Jeep Cherokee

GENERAL INFORMATION
Steering, Suspension, Wheel Alignment, Wheels and Tires
Motorist Assurance Program
Standards For Automotive Repair

All Makes and Models

INTRODUCTION TO MOTORIST ASSURANCE PROGRAM (MAP)

CONTENTS

TIE ROD ENDS (INNER AND OUTER)
TRACK BARS
TRAILING ARMS
WHEEL BEARINGS, RACES AND SEALS

Wheel Alignment

WHEEL ALIGNMENT

Wheels and Tires

TIRES
VALVE STEMS
WHEEL ATTACHMENT HARDWARE
WHEELS (RIMS)

MOTORIST ASSURANCE PROGRAM (MAP)

OVERVIEW

The Motorist Assurance Program is the consumer outreach effort of the Automotive Maintenance and Repair Association, Inc. (AMRA). Participation in the Motorist Assurance Program is drawn from retailers, suppliers, independent repair facilities, vehicle manufacturers and industry associations.

Our organization’s mission is to strengthen the relationship between the consumer and the auto repair industry. We produce materials that give motorists the information and encouragement to take greater responsibility for their vehicles-through proper, manufacturer-recommended, maintenance. We encourage participating service and repair shops (including franchisees and dealers) to adopt 1) a Pledge of Assurance to their Customers and 2) the Motorist Assurance Program Standards of Service. All participating service providers have agreed to subscribe to this Pledge and to adhere to the promulgated Standards of Service demonstrating to their customers that they are serious about customer satisfaction.

These Standards of Service require that an inspection of the vehicle’s (problem) system be made and the results communicated to the customer according to industry standards. Given that the industry did not have such standards, the Motorist Assurance Program successfully promulgated industry inspection communication standards in 1994-95 for the following systems: Exhaust, Brakes, ABS, Steering and Suspension, Engine Maintenance and Performance, HVAC, and Electrical Systems. Further, revisions to all of these inspection communication standards are continually re-published. In addition to these, standards for Drive Train and Transmissions have recently been promulgated. Participating shops utilize these Uniform Inspection & Communication Standards as part of the inspection process and for communicating their findings to their customers.

The Motorist Assurance Program continues to work cooperatively and proactively with government agencies and consumer groups toward solutions that both benefit the customer and are mutually acceptable to both regulators and industry. We maintain the belief that industry must retain control over how we conduct our business, and we must be viewed as part of the solution and not part of the problem. Meetings with state and other government officials (and their representatives), concerned with auto repair and/or consumer protection, are conducted. Feedback from these sessions is brought back to the association, and the program adjusted as needed.

To assure auto repair customers recourse if they were not satisfied with a repair transaction, the Motorist Assurance Program offers mediation and arbitration through MAP/BBB-CARE and other non-

profit organizations. MAP conducted pilot programs in twelve states before announcing the program nationally in October, 1998. During the pilots, participating repair shops demonstrated their adherence to the Pledge and Standards and agreed to follow the UICS in communicating the results of their inspection to their customers. To put some "teeth" in the program, an accreditation requirement for shops was initiated. The requirements are stringent, and a self-policing method has been incorporated which includes the "mystery shopping" of outlets.

We welcome you to join us as we continue our outreach... with your support, both the automotive repair industry and your customers will reap the benefits. Please visit MAP at our Internet site www. motorist.org or contact us at:

1444 I Street, NW Suite 700
Washington, DC 20005
Phone (202) 712-9042 Fax (202) 216-9646
January 1999

MAP UNIFORM INSPECTION GENERAL GUIDELINES

OVERVIEW OF SERVICE REQUIREMENTS & SUGGESTIONS

It is MAP policy that all exhaust, brake, steering, suspension, wheel alignment, drive-line, engine performance and maintenance, and heating, ventilation and air conditioning, and electrical services be offered and performed under the standards and procedures specified in these sections.

Before any service is performed on a vehicle, an inspection of the appropriate system must be performed. The results of this inspection must be explained to the customer and documented on an inspection form. The condition of the vehicle and its components will indicate what services/part replacements may be "Required" or "Suggested". In addition, suggestions may be made to satisfy the requests expressed by the customer.

When a component is suggested or required to be repaired or replaced, the decision to repair or replace must be made in the customer's best interest, and at his or her choice given the options available.

This section lists the various parts and conditions that indicate a required or suggested service or part replacement. Although this list is extensive, it is not fully inclusive. In addition to this list, a technician may make a suggestion. However, any suggestions must be based on substantial and informed experience, or the vehicle manufacturer's recommended service interval and must be documented.

Some conditions indicate that service or part replacement is required because the part in question is no longer providing the function for which it is intended, does not meet a vehicle manufacturer's design specification or is missing.

Example:
An exhaust pipe has corroded severely and has a hole in it through which exhaust gases are leaking. Replacement of the exhaust pipe in this case is required due to functional failure.

Example:
A brake rotor has been worn to the point where it measures less than the vehicle manufacturer's discard specifications. Replacement of the rotor is required because it does not meet design specifications.

Some conditions indicate that a service or part replacement is suggested because the part is close to the end of its useful life or addresses a customer's need, convenience or request. If a customer's vehicle has one of these conditions, the procedure may be only to suggest service.

Example:
An exhaust pipe is rusted, corroded or weak, but no leaks are present. In this case, the exhaust pipe has not failed. However, there is evidence that the pipe may need replacement in the near future. Replacement of the pipe may be suggested for the customer's convenience in avoiding a future problem.

Example:
The customer desires improved ride and/or handling, but the vehicle's shocks or struts have not failed. In this case, replacement may be suggested to satisfy the customer's wishes. In this case, replacement of the shocks or struts may not be sold as a requirement.

A customer, of course, has the choice of whether or not a shop will service his or her vehicle. He or she may decide not to follow some of your suggestions. When a repair is required, a MAP shop must refuse partial service on that system if, in the judgment of the service provider, proceeding with the work could create or continue an unsafe condition. When a procedure states that required or suggested repair or replacement is recommended, the customer must be informed of the generally acceptable repair/replacement options whether or not performed by the shop.

When presenting suggested repairs to the customer, you must present the facts, allowing the customer to draw their own conclusions and make an informed decision about how to proceed.

The following reasons may be used for required and suggested services. These codes are shown in the "Code" column of the MAP Uniform Inspection & Communications Standards that follow:

Reasons to Require Repair or Replacement

A - Part no longer performs intended purpose
B - Part does not meet a design specification (regardless of performance)
C - Part is missing

NOTE: When a repair is required, the shop must refuse partial service to the system in question, if the repair creates or continues an unsafe condition.

Reasons to Suggest Repair or Replacement

1 - Part is close to the end of its useful life (just above discard specifications, or weak; failure likely to occur soon, etc.)
2 - To address a customer need, convenience, or request (to stiffen ride, enhance performance, eliminate noise, etc.)
3 - To comply with maintenance recommended by the vehicle's Original Equipment Manufacturer (OEM)
4 - Technician's recommendation based on substantial and informed experience

NOTE: Suggested services are always optional. When presenting suggested repairs to the customer, you must present

the facts, allowing the customer to draw their own conclusions and make an informed decision about how to proceed.

STEERING AND SUSPENSION

SERVICE PROCEDURES REQUIRED AND SUGGESTED FOR PROPER VEHICLE OPERATION

Steering and suspension are complex systems made up of a variety of interdependent components. For proper vehicle handling, ride, and tire wear, a thorough inspection is required whenever suspension work is being performed.

Conditions listed assume that the problem has been isolated to the specific component by proper testing procedures.

NOTE: When replacing steering and/or suspension components which may affect an alignment angle, you are required to check and adjust alignment as needed. Refer to the OEM specifications.

CAUTION: DO NOT use ride height altering or load compensating components, such as variable rate springs and coil over shocks, on vehicles with height or load sensing proportioning valve-equipped braking systems, unless these components are original equipment.

AIR RIDE SUSPENSION

NOTE: Depending on the air suspension design, there are some aftermarket products available to eliminate the air ride suspension on certain vehicles. If the system has been eliminated with one of these products, then no service is suggested or required.

AIR RIDE SUSPENSION - AIR SHOCKS AND AIR STRUTS

NOTE: This section covers the air spring portion of the air shock or strut. For damping portion of shock or strut conditions and procedures, refer to the SHOCK ABSORBERS, STRUT CARTRIDGES AND STRUT ASSEMBLIES section.

AIR RIDE SUSPENSION - AIR SHOCK AND AIR STRUT INSPECTION

Condition	Code	Procedure
Inner fabric of air bag damaged	A	Require replacement.
Leaking	A	Require repair or replacement.
Outer covering of air bag is cracked to the extent that inner fabric of air bag is visible	1	Suggest replacement.

AIR RIDE SUSPENSION - AIR SPRING VALVES

AIR RIDE SUSPENSION - AIR SPRING VALVE INSPECTION

Condition	Code	Procedure

Condition	Code	Procedure
Attaching hardware incorrect	A	Require replacement of incorrect part.
Attaching hardware loose	A	Require repair or replacement of loose part.
Attaching hardware missing	C	Require replacement of missing part.
Attaching hardware threads damaged	A	Require repair or replacement of part with damaged threads.
Attaching hardware threads stripped (threads missing)	A	Require replacement of part with stripped threads.
Blocked	A	Require repair or replacement.
Connector bent	A	Require repair or replacement.
Connector broken	A	Require replacement.
Connector loose	A	Require repair or replacement.
Inoperative	A	Require repair or replacement.
Leaking	A	Require repair or replacement.
Restricted	A	Require repair or replacement.

AIR RIDE SUSPENSION - AIR SPRINGS

AIR RIDE SUSPENSION – AIR SPRING INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require replacement of broken part.
Attaching hardware incorrect	A	Require replacement of incorrect part.
Attaching hardware loose	A	Require repair or replacement of loose part.
Attaching hardware missing	C	Require replacement of missing part
Attaching hardware threads damaged	A	Require repair or replacement of part with damaged threads.
Attaching hardware threads stripped (threads missing)	A	Require replacement of part with stripped threads.
Collar cracked	A	Require replacement.
End cap cracked	A	Require replacement.
Inner fabric of bag damaged	A	Require replacement.
Leaking	A	Require repair or replacement.
Outer covering of air bag is cracked to the extent that inner fabric of air bag is visible	1	Suggest replacement.
Piston cracked	A	Require replacement.

AIR RIDE SUSPENSION - COMPRESSORS

AIR RIDE SUSPENSION - COMPRESSOR INSPECTION

Condition	Code	Procedure
Attaching hardware bent	B	Require repair or replacement of bent part.
Attaching hardware broken	A	Require replacement of broken part.
Attaching hardware loose	A	Require repair or replacement of loose part.
Attaching hardware missing	C	Require replacement of missing part.
Attaching hardware threads damaged	A	Require repair or replacement of part with damaged threads.
Attaching hardware threads stripped (threads missing)	A	Require replacement of part with stripped threads.
Connector bent	A	Require repair or replacement.
Connector broken	A	Require replacement.
Connector loose	A	Require repair or replacement.
Does not build pressure	A	(1) Further inspection required.
Excessive run time	B	(2) Further inspection required.
Inoperative	A	Require replacement.
Leaking	A	Require repair or replacement.
Missing	C	Require replacement.

(1) - If failure to build pressure is traced to the compressor, require replacement.
(2) - If excessive run time is traced to the compressor, require replacement.

AIR RIDE SUSPENSION - HEIGHT SENSORS

AIR RIDE SUSPENSION - HEIGHT SENSOR INSPECTION

Condition	Code	Procedure
Attaching hardware bent	B	Require repair or replacement of bent part.
Attaching hardware broken	A	Require replacement of broken part.
Attaching hardware corroded, affecting structural integrity	A	Require replacement of corroded part.
Attaching hardware loose	A	Require repair or replacement of loose part.
Attaching hardware missing	C	Require replacement of missing part.
Attaching hardware		

threads damaged	A	Require repair or replacement of part with damaged threads.
Attaching hardware threads stripped (threads missing)	A	Require replacement of part with stripped threads.
Dust boot missing	2	(1) Suggest replacement.
Dust boot split	2	(1) Suggest replacement.
Dust boot torn	2	(1) Suggest replacement.
Housing cracked	A	Require replacement.
Lead routing incorrect	B	Require rerouting according to vehicle manufacturer's specifications.
Loose	B	Require adjustment to vehicle manufacturer's specifications.
Missing	C	Require replacement.
Output signal incorrect	A	Require repair or replacement.
Wire lead damaged	A	Require repair or replacement.

(1) - This condition can lead to damage of the sliding magnet, which, in turn, causes premature sensor failure.

AIR RIDE SUSPENSION - MODULES

AIR RIDE SUSPENSION - MODULE INSPECTION

Condition	Code	Procedure
Attaching hardware loose	A	Require repair or replacement of loose part.
Attaching hardware missing	C	Require replacement of missing part.
Attaching hardware threads damaged	A	Require repair or replacement of part with damaged threads.
Attaching hardware threads stripped (threads missing)	A	Require replacement of part with stripped threads.
Housing cracked	2	Suggest repair or replacement.
Inoperative	A	Require replacement.
Missing	C	Require replacement.

AIR RIDE SUSPENSION - RELAYS (COMPRESSOR)

AIR RIDE SUSPENSION - RELAY (COMPRESSOR) INSPECTION

Condition	Code	Procedure
Housing cracked	2	(1) Suggest replacement.
Intermittent	A	Require replacement.
Missing	C	Require replacement.
Output signal incorrect	A	Require replacement.

(1) - If moisture enters the relay, it can reduce life expectancy or impair function.

AIR RIDE SUSPENSION - SWITCHES (ON/OFF)

AIR RIDE SUSPENSION - SWITCH (ON/OFF) INSPECTION

Condition	Code	Procedure
Broken	A	Require replacement.
Missing	C	Require replacement.
Output signal incorrect	A	Require replacement.

AIR RIDE SUSPENSION - TORSION SPRINGS (COUNTER BALANCING)

AIR RIDE SUSPENSION - TORSION SPRING (COUNTER BALANCING) INSPECTION

Condition	Code	Procedure
Attaching hardware bent	B	Require repair or replacement of bent part.
Attaching hardware broken	A	Require replacement of broken part.
Attaching hardware incorrect	A	Require replacement of incorrect part.
Attaching hardware loose	A	Require repair or replacement of loose part.
Attaching hardware missing	C	Require replacement of missing part.
Attaching hardware threads damaged	A	Require repair or replacement of part with damaged threads.
Attaching hardware threads stripped (threads missing)	A	Require replacement of part with stripped threads.
Broken	A	Require replacement.
Missing	C	Require replacement.

AIR RIDE SUSPENSION - TUBING

AIR RIDE SUSPENSION - TUBING INSPECTION

Condition	Code	Procedure
Attaching hardware incorrect	A	Require replacement of incorrect part.
Attaching hardware loose	A	Require repair or replacement of loose part.
Attaching hardware missing	C	Require replacement of missing part.
Blocked	A	Require repair or replacement.
Fitting incorrect	B	Require replacement.
Leaking	A	Require repair or replacement.
Line type incorrect	B	Require replacement.
Missing	C	Require replacement.
Restricted	A	Require repair or replacement.
Routed incorrectly	B	Require routing correction.

AIR RIDE SUSPENSION - WARNING LAMPS

AIR RIDE SUSPENSION - WARNING LAMP INSPECTION

Condition	Code	Procedure
Bulb burned out	A	Require replacement.
Warning light does not come on during bulb check	..	Further inspection required to determine cause.
Warning light flashes	..	Further inspection required to determine cause.
Warning light is intermittent	..	Further inspection required to determine cause.
Warning light stays on after initial bulb check	..	Further inspection required to determine cause.

AIR RIDE SUSPENSION - WIRING HARNESSES

AIR RIDE SUSPENSION - WIRING HARNESS INSPECTION

Condition	Code	Procedure
Connector bent	A	Require repair or replacement.
Connector broken	A	Require repair or replacement.
Connector loose	A	Require repair or replacement.
Damaged (cut, burned, or chafed)	A	Require repair or replacement.
Excessive resistance	B	Require repair or replacement.
Fuse blown	A	Require replacement.
Fusible link blown	A	Require replacement.
Open	A	Require repair or replacement.
Poor ground	A	Require repair or replacement.
Routed incorrectly	B	Require rerouting according to vehicle manufacturer's specifications.
Shorted	A	Require repair or replacement.
Terminal bent	A	Require repair or replacement.
Terminal broken	A	Require repair or replacement.
Terminal corroded	A	Require repair or replacement.
Terminal loose	A	Require repair or replacement.

BALL JOINTS

Before requiring or suggesting ball joint replacement, the approved OEM procedure must be used to measure ball joint wear. The measurement(s) obtained, along with the vehicle manufacturer's specifications, must be noted on the inspection report. Some states require that these measurements also appear on the invoice.

NOTE: The term "perceptible movement," defined as any visible movement in any direction, has been the industry standard for determining the need for replacement of follower ball joints. Some vehicle manufacturers are now publishing specifications for follower ball joints that were

previously diagnosed by the "perceptible movement" standard. Before requiring or suggesting any parts be replaced based on "perceptible movement," consult your repair manual to determine if OEM specifications exist.

You are not required to replace ball joints in axle sets. However, when replacing a ball joint due to wear exceeding manufacturer's specification, you may suggest replacement of the other ball joint if its measurement shows it is close to the end of its useful life, for preventive maintenance.

BALL JOINT INSPECTION

Condition	Code	Procedure
Attaching hardware bent	B	Require repair or replacement of bent part if available; otherwise, replace ball joint.
Attaching hardware broken	A	Require replacement of broken part if available; otherwise, replace ball joint.
Attaching hardware corroded, affecting structural integrity	A	Require replacement of corroded part if available; otherwise, replace ball joint.
Attaching hardware incorrect	A	Require replacement of incorrect part if available; otherwise, replace ball joint.
Attaching hardware loose	A	Require repair or replacement of loose part if available; otherwise, replace ball joint.
Attaching hardware missing	C	Require replacement of missing part if available; otherwise, replace ball joint.
Attaching hardware threads damaged	A	Require repair or replacement of part with damaged threads if available; otherwise, replace ball joint.
Attaching hardware threads stripped (threads missing)	A	Require replacement of part with stripped threads if available; otherwise, replace ball joint.
Binding	A	(1) Further inspection required.
Grease boot cracked	2	(2) Suggest replacement.
Grease boot missing	2	(3) Suggest replacement.
Grease boot torn	2	(4) Suggest replacement.
Grease fitting broken	A	Require replacement of grease fitting.
Grease fitting missing	C	Require replacement of grease fitting.
Grease fitting won't seal	A	Require replacement of grease fitting.
Greaseable ball joint will		

not take grease	2	(5) Suggest replacement of grease fitting.
Nut on ball joint loose	A	(6) Require repair or replacement.
Pre-load adjustment incorrect	B	Require repair or replacement.
Seized	A	Require replacement.
Stud bent	B	(7) Require replacement.
Stud broken	A	(7) Require replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	(7) Require replacement.
Wear exceeds manufacturer's specifications	B	Require replacement.

(1) - If greaseable, grease ball joint. If problem persists or joint is non-greaseable, require replacement.
(2) - Cracked grease boot will allow contaminants to enter the ball joint and will accelerate wear.
(3) - Lack of grease boot will allow contaminants to enter the ball joint and will accelerate wear.
(4) - Torn grease boot will allow contaminants to enter the ball joint and will accelerate wear.
(5) - If the greaseable ball joint still will not take grease after replacing the grease fitting, suggest replacement of ball joint.
(6) - Check for bent stud or damaged taper hole.
(7) - Check for damaged taper hole.

BUSHINGS

BUSHING INSPECTION

Condition	Code	Procedure
Attaching hardware bent	B	Require repair or replacement of bent part if available; otherwise, replace bushing.
Attaching hardware broken	A	Require replacement of broken part if available; otherwise, replace bushing.
Attaching hardware corroded, affecting structural integrity	A	Require replacement of corroded part if available; otherwise, replace bushing.
Attaching hardware incorrect	A	Require replacement of incorrect part if available; otherwise, replace bushing.
Attaching hardware loose	A	Require repair or replacement of loose part if available; otherwise, replace bushing.
Attaching hardware missing	C	Require replacement of missing part if available; otherwise, replace bushing.
Attaching hardware threads damaged	A	Require repair or replacement

of part with damaged threads if available; otherwise, replace bushing.

Attaching hardware threads stripped (threads missing)	A	Require replacement of part with stripped threads if available; otherwise, replace bushing.
Binding	A	Require repair or replacement.
Deteriorated, affecting performance	A	Require repair or replacement.
Distorted, affecting performance	A	Require repair or replacement.
Leaking (fluid-filled type)	A	Require replacement.
Missing	C	Require replacement.
Noisy	2	(1) Further inspection required.
Rubber separating from internal metal sleeve on bonded bushing	A	Require replacement.
Seized	A	Require replacement.
Shifted (out of position)	B	Require repair or replacement.
Split	A	Require replacement.
Surface cracking (weather-checked)	..	No service suggested or required.

(1) - If noise isolated to bushing, suggest repair or replacement.

CAUTION: Use only approved lubricant on rubber bushings. Petroleum-based lubricants may damage rubber bushings.

CENTER LINKS

CENTER LINK INSPECTION

Condition	Code	Procedure
Attaching hardware incorrect	A	Require replacement of incorrect part, if available; otherwise, replace center link.
Attaching hardware loose	A	Require repair or replacement of loose part, if available; otherwise, replace center link.
Attaching hardware missing	C	Require replacement of missing part, if available; otherwise, replace center link.
Attaching hardware threads damaged	A	Require repair or replacement of part with damaged threads, if available; otherwise, replace center link.
Attaching hardware threads stripped (threads missing)	A	Require replacement of part with stripped threads, if

		available; otherwise, replace center link.
Bent	B	Require replacement.
Binding	A	(1) Further inspection required.
Grease boot cracked	2	(2) Suggest replacement.
Grease boot missing	2	(3) Suggest replacement.
Grease boot torn	2	(4) Suggest replacement.
Grease fitting broken	A	Require replacement of grease fitting.
Grease fitting missing	C	Require replacement of grease fitting.
Grease fitting won't seal	A	Require replacement of grease fitting.
Grease seal missing	2	(3) Suggest replacement.
Grease seal torn	2	(4) Suggest replacement.
Looseness (perceptible horizontal movement)	1	(5) Suggest replacement.
Looseness that is excessive	B	(5)(6) Require replacement.
Seized	A	Require replacement.
Stud bent	B	(7) Require replacement.
Stud broken	A	(7) Require replacement.
Stud loose in taper hole	A	(7) Require repair or replacement.
Taper hole elongated	A	(8) Require replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	(7) Require replacement.
Wear exceeds manufacturer's specifications	B	Require replacement.

(1) - If greaseable, grease joint. If problem persists or joint is non-greaseable, require replacement.
(2) - Cracked grease boot will allow contaminants to enter the joint and will accelerate wear.
(3) - Lack of grease boot will allow contaminants to enter the joint and will accelerate wear.
(4) - Torn grease boot will allow contaminants to enter the joint and will accelerate wear.
(5) - If manufacturer's procedures for inspection exist, use those procedures; otherwise, use an approved inspection method such as the dry park check.
CAUTION: DO NOT use pliers or pry bar to check ball and socket movement. Use only moderate hand pressure.
(6) - Excessive looseness is defined as being significant enough to affect vehicle handling or structural integrity.
(7) - Check for damaged taper hole.
(8) - Check for damaged stud.

CONTROL ARM SHAFTS

CONTROL ARM SHAFT INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require replacement of broken

		part, if available; otherwise, replace shaft.
Attaching hardware loose	A	Require repair or replacement of loose part, if available; otherwise, replace shaft.
Attaching hardware missing	C	Require replacement of missing part, if available; otherwise, replace shaft.
Attaching hardware threads damaged	A	Require repair or replacement of part with damaged threads, if available; otherwise, replace shaft.
Attaching hardware threads stripped (threads missing)	A	Require replacement of part with stripped threads, if available; otherwise, replace shaft.
Bent	B	Require replacement.
Shaft bushing surface undersized (worn)	B	Require replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.

CONTROL ARMS

CONTROL ARM INSPECTION

Condition	Code	Procedure
Attaching hardware bent	B	Require repair or replacement of bent part, if available; otherwise, replace control arm.
Attaching hardware broken	A	Require replacement of broken part, if available; otherwise, replace control arm.
Attaching hardware corroded, affecting structural integrity	A	Require replacement of corroded part, if available; otherwise, replace control arm.
Attaching hardware incorrect	A	Require replacement of incorrect part, if available; otherwise, replace control arm.
Attaching hardware loose	A	Require repair or replacement of loose part, if available; otherwise, replace control arm.
Attaching hardware missing	C	Require replacement of missing part, if available; otherwise, replace control arm.
Attaching hardware threads damaged	A	Require repair or replacement of part with damaged threads,

		if available; otherwise, replace control arm.
Attaching hardware threads stripped (threads missing)	A	Require replacement of part with stripped threads, if available; otherwise, replace control arm.
Bent	B	Require replacement.
Bushing hole oversized	B	Require replacement.
Ball joint hole oversized (loose interference or press fit)	B	(1) Further inspection required.
Corroded, affecting structural integrity	A	Require replacement.
Holes distorted	A	Require replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.

(1) - If oversized ball joint is available, require replacement of ball joint. If oversized ball joint is not available, require replacement of control arm.

DRAG LINKS

DRAG LINK INSPECTION

Condition	Code	Procedure
Attaching hardware incorrect	A	Require replacement of incorrect part, if available; otherwise, replace drag link.
Attaching hardware loose	A	Require repair or replacement of loose part, if available; otherwise, replace drag link.
Attaching hardware missing	C	Require replacement of missing part, if available; otherwise, replace drag link.
Attaching hardware threads damaged	A	Require repair or replacement of part with damaged threads, if available; otherwise, replace drag link.
Attaching hardware threads stripped (threads missing)	A	Require replacement of part with stripped threads, if available; otherwise, replace drag link.
Bent	B	Require replacement.
Binding	A	(1) Further inspection required.
Grease boot cracked	2	(2) Suggest replacement.
Grease boot missing	2	(3) Suggest replacement.
Grease boot torn	2	(4) Suggest replacement.
Grease fitting broken	A	Require replacement of grease fitting.

Grease fitting missing	C	Require replacement of grease fitting.
Grease fitting won't seal	A	Require replacement of grease fitting.
Grease seal missing	2	(5) Suggest replacement.
Grease seal torn	2	(4) Suggest replacement.
Looseness (perceptible horizontal movement)	1	(6) Suggest replacement.
Looseness that is excessive	B	(6)(7) Require replacement.
Seized	A	Require replacement.
Stud bent	B	(8) Require replacement.
Stud broken	A	(8) Require replacement.
Stud loose in taper hole	A	(8) Require repair or replacement.
Taper hole elongated	A	(9) Require replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	(8) Require replacement.
Wear exceeds manufacturer's specifications	B	Require replacement.

(1) - If greaseable, grease joint. If problem persists or joint is non-greaseable, require replacement.
(2) - Cracked grease boot will allow contaminants to enter the joint and will accelerate wear.
(3) - Lack of grease boot will allow contaminants to enter the joint and will accelerate wear.
(4) - Torn grease boot will allow contaminants to enter the joint and will accelerate wear.
(5) - Missing grease seal will allow contaminants to enter the joint and will accelerate wear.
(6) - If manufacturer's procedures for inspection exist, use those procedures; otherwise, use an approved inspection method such as the dry park check.
CAUTION: DO NOT use pliers or pry bar to check ball and socket movement. Use only moderate hand pressure.
(7) - Excessive looseness is defined as being significant enough to affect vehicle handling or structural integrity.
(8) - Check for damaged taper hole.
(9) - Check for damaged stud.

ELECTRONIC RIDE CONTROL SHOCKS AND STRUTS

NOTE: This section covers the electronic damping control portion of the electronic shock or strut. For dampening portion of shock or strut conditions and procedures, refer to the SHOCK ABSORBERS, STRUT CARTRIDGES AND STRUT ASSEMBLIES section.

ELECTRONIC RIDE CONTROL SHOCK AND STRUT INSPECTION

Condition	Code	Procedure
Connector bent	A	Require repair or replacement.
Connector broken	A	Require repair or replacement.
Connector loose	A	Require repair or replacement.
Electronic valve control		

inoperative	2	(1) Suggest replacement.
Terminal bent	A	Require repair or replacement.
Terminal broken	A	Require repair or replacement.
Terminal corroded	A	Require repair or replacement.
Terminal loose	A	Require repair or replacement.

(1) - It is acceptable to replace with a non-electronically controlled unit, where available.

IDLER ARMS

IDLER ARM INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require replacement of broken part, if available; otherwise, replace idler arm.
Attaching hardware incorrect	A	Require replacement of incorrect part, if available; otherwise, replace idler arm.
Attaching hardware loose	A	Require repair or replacement of loose part, if available; otherwise, replace idler arm.
Attaching hardware missing	C	Require replacement of missing part, if available; otherwise, replace idler arm.
Attaching hardware threads damaged	A	Require repair or replacement of part with damaged threads, if available; otherwise, replace idler arm.
Attaching hardware threads stripped (threads missing)	A	Require replacement of part with stripped threads, if available; otherwise, replace idler arm.
Binding	A	(1) Further inspection required.
Grease boot cracked	2	(2) Suggest replacement.
Grease boot missing	2	(3) Suggest replacement.
Grease boot torn	2	(4) Suggest replacement.
Grease fitting broken	A	Require replacement of grease fitting.
Grease fitting missing	C	Require replacement of grease fitting.
Grease fitting won't seal	A	Require replacement of grease fitting.
Grease seal missing	2	(5) Suggest replacement.
Grease seal torn	2	(4) Suggest replacement.
Greaseable joint will not take grease	2	(1) Suggest replacement of grease fitting.
Looseness at frame bracket end	B	(6)(7) Require repair or replacement.

Looseness at link end (perceptible horizontal movement)	1	(8) Suggest replacement.
Looseness at link end that is excessive	B	(8)(9) Require replacement.
Mounted out of position (center link not parallel)	B	Require repositioning.
Nut on stud loose	A	(10) Require repair or replacement.
Seized	A	Require replacement.
Stud bent	B	(11) Require replacement.
Stud broken	A	(11) Require replacement.
Taper hole elongated	A	(12) Require replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	(11) Require replacement.
Wear exceeds manufacturer’s specifications	B	Require replacement.

(1) - If greaseable, grease joint. If problem persists or joint is non-greaseable, require replacement.
(2) - Cracked grease boot will allow contaminants to enter joint and will accelerate wear.
(3) - Lack of grease boot will allow contaminants to enter joint and will accelerate wear.
(4) - Torn grease boot will allow contaminants to enter joint and will accelerate wear.
(5) - Missing grease seal will allow contaminants to enter joint and will accelerate wear.
(6) - If manufacturer’s procedures and specifications exist, use those procedures and specifications; otherwise, use an approved inspection method such as the dry park check.
(7) - Looseness is defined as movement that creates excessive toe change.
(8) - If manufacturer’s procedures for inspection exist, use those procedures; otherwise, use an approved inspection method such as the dry park check.
CAUTION: DO NOT use pliers or pry bar to check ball and socket movement. Use only moderate hand pressure.
(9) - Excessive looseness is defined as significant enough to affect vehicle handling or structural integrity.
(10) - Check for bent stud or damaged taper hole.
(11) - Check for damaged taper hole.
(12) - Check for damaged stud.

KING PINS

You are not required to replace king pins in axle sets. However, when replacing a king pin due to wear exceeding manufacturer’s specifications, you may suggest replacement of the other king pin on the axle if its measurement shows it is close to the end of its useful life.

KING PIN INSPECTION

Condition	Code	Procedure
Bearing balls pitted	A	Require replacement.
Bearing balls worn	A	Require replacement.
Bearing races pitted	A	Require replacement.

Bearing races worn	A	Require replacement.
Bearing rollers pitted	A	Require replacement.
Bearing rollers worn	A	Require replacement.
Bearing seal bent	2	Suggest replacement of seal or bearing.
Bearing seal missing	2	Suggest replacement of seal or bearing.
Bearing seal torn	2	Suggest replacement of seal or bearing.
Binding	A	Require repair or replacement of affected parts.
End caps missing	C	Require replacement of missing part, if available; otherwise, replace king pin.
End play exceeds specifications	B	Require repair.
Grease fitting broken	A	Require replacement of grease fitting.
Grease fitting missing	C	Require replacement of grease fitting.
Grease fitting won't seal	A	Require replacement of grease fitting.
Locating pins missing	C	Require replacement of missing part, if available; otherwise, replace king pin.
Looseness exceeds manufacturer's specifications	B	Require replacement of worn parts.
Seized	A	Require replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.
Will not take grease	2	(1) Suggest replacement of grease fitting.

(1) - If king pin will not take grease after replacement of grease fitting, suggest replacement of king pin.

PITMAN ARMS

PITMAN ARM INSPECTION

Condition	Code	Procedure
Attaching hardware incorrect	A	Require replacement of incorrect part, if available; otherwise, replace pitman arm.
Attaching hardware loose	A	Require repair or replacement of loose part, if available; otherwise, replace pitman arm.
Attaching hardware missing	C	Require replacement of missing part, if available; otherwise, replace pitman arm.
Attaching hardware threads damaged	A	Require repair or replacement of part with damaged threads, if available; otherwise,

Condition	Code	Procedure
		replace pitman arm.
Attaching hardware threads stripped (threads missing)	A	Require replacement of part with stripped threads, if available; otherwise, replace pitman arm.
Bent	B	Require replacement.
Binding	A	(1) Further inspection required.
Grease boot cracked	2	(2) Suggest replacement.
Grease boot missing	2	(3) Suggest replacement.
Grease boot torn	2	(4) Suggest replacement.
Grease fitting broken	A	Require replacement grease fitting.
Grease fitting missing	C	Require replacement of grease fitting.
Grease fitting won't seal	A	Require replacement of grease fitting.
Grease seal missing	2	(3) Suggest replacement of seal.
Grease seal torn	2	(4) Suggest replacement of seal.
Looseness (perceptible horizontal movement)	1	(5) Suggest replacement.
Looseness that is excessive	B	(5)(6) Require replacement.
Nut on stud loose	A	(7) Require repair or replacement.
Seized	A	Require replacement.
Splines damaged	A	Require repair or replacement.
Splines stripped (splines missing)	A	Require replacement.
Stud bent	B	(8) Require replacement.
Stud broken	A	(8) Require replacement.
Stud loose in taper hole	A	(8) Require repair or replacement.
Taper hole elongated	A	(9) Require replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	(8) Require replacement.

(1) - If greaseable, grease joint. If problem persists or joint is non-greaseable, require replacement.
(2) - Cracked grease boot will allow contaminants to enter joint and will accelerate wear.
(3) - Lack of grease boot will allow contaminants to enter joint and will accelerate wear.
(4) - Torn grease boot will allow contaminants to enter joint and will accelerate wear.
(5) - If manufacturer's procedures for inspection exist, use those procedures; otherwise, use an approved inspection method such as the dry park check.
CAUTION: DO NOT use pliers or pry bar to check ball and socket movement. Use only moderate hand pressure.
(6) - Excessive looseness is defined as being significant enough to affect vehicle handling or structural integrity.
(7) - Check for bent stud of damaged taper hole.
(8) - Check for damaged taper hole.
(9) - Check for damaged stud.

POWER STEERING HOSES

POWER STEERING HOSE INSPECTION

Condition	Code	Procedure
Blistered	B	Require replacement.
Blocked	A	Require repair or replacement.
Fitting threads damaged	A	Require repair or replacement.
Fitting threads stripped (threads missing)	A	Require replacement.
Inner fabric (webbing) cut	A	Require replacement.
Leaking	A	Require repair or replacement.
Missing	C	Require replacement.
Outer covering is cracked to the extent that the inner fabric of hose is visible	B	Require replacement.
Restricted	A	Require repair or replacement.

POWER STEERING (HYDRAULIC) PUMPS

If diagnosis has determined that complete disassembly is necessary to determine the extent of the system failure, the suggestion may be made to rebuild or replace the power steering pump. Repair or replacement of the following components may be required if performed as part of a power steering pump overhaul or rebuild service to meet a minimum rebuild standard.

POWER STEERING (HYDRAULIC) PUMP INSPECTION

Condition	Code	Procedure
Attaching hardware bent	B	Require repair or replacement of bent part.
Attaching hardware broken	A	Require replacement of broken part.
Attaching hardware loose	A	Require repair or replacement of loose part.
Attaching hardware missing	C	Require replacement of missing part.
Attaching hardware threads damaged	A	Require repair or replacement of part with damaged threads.
Attaching hardware threads stripped (threads missing)	A	Require replacement of part with stripped threads.
Belt alignment incorrect	B	(1) Further inspection required.
Belt cracked	1	Suggest replacement.
Belt frayed	1	Suggest replacement.
Belt missing	C	Require replacement.
Belt noisy	2	(2) Further inspection required.
Belt plies separated	A	Require replacement.

Condition	Code	Procedure
Belt tension out of specification	B	Require adjustment or replacement.
Belt worn beyond adjustment range	B	Require replacement.
Belt worn so it contacts bottom of pulley	A	Require replacement.
Binding	A	Require repair or replacement.
Fluid at or beyond service interval	3	Suggest fluid change.
Fluid contaminated	B	(3) Require flushing and refilling of the system.
Fluid level incorrect	B	Require adjustment of fluid level.
Inadequate assist	A	(4) Further inspection required.
Leaking	A	Require repair or replacement.
Noise	2	(5) Further inspection required.
Pulley bent	A	Require repair or replacement of pulley.
Pulley missing	C	Require replacement of pulley.
Remote reservoir leaking	A	Require replacement of reservoir,
Reservoir cap broken	A	Require replacement of cap.
Reservoir cap missing	C	Require replacement of cap.
Seized	A	Require replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.

(1) - Determine cause of incorrect alignment and require repair.
(2) - Determine cause of noise and suggest repair.
(3) - Determine and correct source of contamination. OEM specifications must be followed for fluid type.
(4) - If pump is source of inadequate assist, require repair or replacement.
(5) - If noise is isolated to pump, suggest repair or replacement.

RADIUS ARMS

RADIUS ARM INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require replacement of broken part.
Attaching hardware incorrect	A	Require replacement of incorrect part.
Attaching hardware loose	A	Require repair or replacement of loose part.
Attaching hardware missing	C	Require replacement of missing part.
Attaching hardware threads damaged	A	Require repair or replacement of part with damaged threads.

Attaching hardware threads stripped (threads missing)	A	Require replacement of part with stripped threads.
Bent	B	Require replacement.
Corroded, affecting structural integrity	A	Require replacement.
Holes distorted	A	Require replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.

RELAY RODS

RELAY ROD INSPECTION

Condition	Code	Procedure
Attaching hardware incorrect	A	Require replacement of incorrect part, if available; otherwise, replace relay rod.
Attaching hardware loose	A	Require repair or replacement of loose part, if available; otherwise, replace relay rod.
Attaching hardware missing	C	Require replacement of missing part, if available; otherwise, replace relay rod.
Attaching hardware threads damaged	A	Require repair or replacement of part with damaged threads, if available; otherwise, replace relay rod.
Attaching hardware threads stripped (threads missing)	A	Require replacement of part with stripped threads, if available; otherwise, replace relay rod.
Bent	B	Require replacement.
Binding	A	(1) Further inspection required.
Grease boot cracked	2	(2) Suggest replacement.
Grease boot missing	2	(3) Suggest replacement.
Grease boot torn	2	(4) Suggest replacement.
Grease fitting broken	A	Require replacement grease fitting.
Grease fitting missing	C	Require replacement of grease fitting.
Grease fitting won’t seal	A	Require replacement of grease fitting.
Grease seal missing	2	(3) Suggest replacement.
Grease seal torn	2	(4) Suggest replacement.
Looseness (perceptible horizontal movement)	1	(5) Suggest replacement.
Looseness that is excessive	B	(5)(6) Require replacement.
Seized	A	Require replacement.
Stud bent	B	(7) Require replacement.

Stud loose in taper hole	A	.... (7) Require repair or replacement.
Taper hole elongated	A	.... (8) Require replacement.
Threads damaged	A	.. Require repair or replacement.
Threads stripped (threads missing)	A	.... (7) Require replacement.
Wear exceeds manufacturer's specifications	B	.... Require replacement.

(1) - If greaseable, grease joint. If problem persists or joint is non-greaseable, require replacement.
(2) - Cracked grease boot will allow contaminants to enter the joint and will accelerate wear.
(3) - Lack of grease boot will allow contaminants to enter the joint and will accelerate wear.
(4) - Torn grease boot will allow contaminants to enter the joint and will accelerate wear.
(5) - If manufacturer's procedures for inspection exist, use those procedures; otherwise, use an approved inspection method such as the dry park check.
CAUTION: DO NOT use pliers or pry bar to check ball and socket movement. Use only moderate hand pressure.
(6) - Excessive looseness is defined as being significant enough to affect vehicle handling or structural integrity.
(7) - Check for damaged taper hole.
(8) - Check for damaged stud.

SHOCK ABSORBERS, STRUT CARTRIDGES AND STRUT ASSEMBLIES

You are not required to replace shocks or struts in axle sets. However, when replacing a shock or strut due to the conditions that follow, you may suggest replacement of the other shock or strut on the same axle for improved performance and preventive maintenance.

* Part is close to the end of its useful life
* To extend tire life
* To balance ride and handling
* To improve stopping distance

When replacing steering and/or suspension components which may affect an alignment angle, you are required to check and adjust alignment as needed. Refer to the OEM specifications.

Under no circumstances should a technician bend struts or strut housings.

A vehicle's load-carrying and handling abilities are limited by its suspension, tires, brakes, and driveline. Installing coil over shocks or any other load assist device does not increase the vehicle's load capacity. See the vehicle owner's manual for more details.

NOTE: If vehicle is equipped with original equipment coil over shocks, apply the conditions for coil springs from the SPRINGS - COIL, LEAF AND TORSION BAR section of the STEERING AND SUSPENSION guidelines. If the vehicle is equipped with add-on coil over shocks, you may suggest replacing the shocks with standard shocks for any spring-related condition.

SHOCK ABSORBER, STRUT CARTRIDGE AND STRUT ASSEMBLY INSPECTION

Condition	Code	Procedure
Attaching hardware bent	B	Require repair or replacement of bent part, if available; otherwise, replace shock or strut.
Attaching hardware broken	A	Require replacement of broken part, if available; otherwise, replace shock or strut.
Attaching hardware corroded, affecting structural integrity	A	Require replacement of corroded part, if available; otherwise, replace shock or strut.
Attaching hardware incorrect	A	Require replacement of incorrect part, if available; otherwise, replace shock or strut.
Attaching hardware loose	A	Require repair or replacement of loose part, if available; otherwise, replace shock or strut.
Attaching hardware missing	C	Require replacement of missing part, if available; otherwise, replace shock or strut.
Attaching hardware threads damaged	A	Require repair or replacement of part with damaged threads, if available; otherwise, replace shock or strut.
Attaching hardware threads stripped (threads missing)	A	Require replacement of part with stripped threads, if available; otherwise, replace shock or strut.
Binding	A	Require replacement.
Body dented	A	(1) Further inspection required.
Body punctured	A	Require replacement.
Brake hose bracket bent	B	Require repair or replacement.
Brake hose bracket missing	C	Require replacement.
Brake hose bracket threads damaged	A	Require repair or replacement.
Brake hose bracket threads stripped (threads missing)	C	Require replacement.
Compression bumper missing	C	Require replacement of compression bumper.
Compression bumper split	1	Suggest replacement of compression bumper.
Damping (none)	A	Require replacement.
Dust boot (bellows) split	2	(2) Suggest replacement of boot.

Dust boot (bellows) missing	2	(2) Suggest replacement of boot.
Dust boot (bellows) torn	2	(2) Suggest replacement of boot.
Dust shield broken	2	(2) Suggest replacement.
Dust shield missing	2	(2) Suggest replacement.
Gland nut (strut housing cap) is not removable using appropriate tool	A	(3) Require replacement of nut and/or housing.
Gland nut (strut housing cap) threads damaged	A	Require repair or replacement of nut.
Gland nut (strut housing cap) threads stripped (threads missing)	A	Require replacement of nut.
Housing dented	A	(1) Further inspection required.
Housing punctured	A	Require replacement.
Jounce bumper missing	C	Require replacement of jounce bumper.
Jounce bumper split	1	Suggest replacement of jounce bumper.
Leaking oil, enough for fluid to be running down the body	A	(4) Require replacement.
Noise	2	(5) Further inspection required.
Piston rod bent	A	Require replacement.
Piston rod broken	A	Require replacement.
Piston rod has surface defect	2	Suggest replacement.
Piston rod threads damaged	A	Require repair or replacement.
Piston rod threads stripped (threads missing)	A	Require replacement.
Seized	A	Require replacement.
Shock missing	C	Require replacement.
Strut housing bent	A	Require replacement.
Strut housing cap (gland nut) is not removable using appropriate tool	A	(3) Require replacement of nut and/or housing.
Strut housing cap (gland nut) threads damaged	A	Require repair or replacement of nut.
Strut housing cap (gland nut) threads stripped (threads missing)	A	Require replacement of nut.
Strut housing severely corroded, affecting structural integrity	A	Require replacement.
Strut housing threads damaged	A	Require repair or replacement.
Strut housing threads stripped (threads missing)	A	Require replacement.
Tire cupping	A	(6) Further inspection required.

(1) - Require replacement of units where dents restrict shock or strut piston rod movement. If dents don't restrict movement, no service is suggested or required. Especially critical on mono-tube shocks.
(2) - This condition can lead to damage of the piston rod, which, in turn, causes premature piston rod seal wear.
(3) - Only required if replacing cartridge.
(4) - CAUTION: If the strut cartridge has been replaced previously, the oil on the strut housing may be filler oil. The technician must identify the source of the oil.
(5) - If noise is isolated to shock or strut, suggest replacement.
(6) - Although shocks or struts may have contributed to tire cupping, an inspection is needed of the entire suspension system. If the shock or strut is found to be contributing to the tire cupping, require replacement.

SPINDLES

SPINDLE INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require replacement of broken part.
Attaching hardware loose	A	Require repair or replacement of loose part.
Attaching hardware missing	C	Require replacement of missing part.
Attaching hardware threads damaged	A	Require repair or replacement of part with damaged threads.
Attaching hardware threads stripped (threads missing)	A	Require replacement of part with stripped threads.
Bent	B	Require replacement.
Broken	A	Require replacement.
Race seat area undersized	B	Require replacement.
Scored	A	Require repair or replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.

SPRINGS - COIL, LEAF AND TORSION BAR

When springs are replaced, it is suggested, but not required, that both springs on an axle be replaced to maintain equal height from side to side and to provide a balanced ride and proper handling.

When variable rate springs are installed in place of conventional coil springs, they must be installed in axle sets to ensure proper handling, uniform ride, and proper chassis height.

Erroneous height measurements may result from: improper tire inflation, non-standard tire or wheel size, and heavy load in vehicle or trunk.

SPRING (COIL, LEAF AND TORSION BAR) INSPECTION

Condition	Code	Procedure
Attaching hardware bent	B	Require repair or replacement of bent part.
Attaching hardware broken	A	Require replacement of broken part.
Attaching hardware corroded, affecting structural integrity	A	Require replacement of corroded part.
Attaching hardware incorrect	A	Require replacement of incorrect part.
Attaching hardware loose	A	Require repair or replacement of loose part.
Attaching hardware missing	C	Require replacement of missing part.
Attaching hardware threads damaged	A	Require repair or replacement of part with damaged threads.
Attaching hardware threads stripped (threads missing)	A	Require replacement of part with stripped threads.
Broken (all springs except secondary leave(s) on multi-leaf springs)	A	Require replacement.
Coil clash	..	(1) Require ride height check.
Coil spring insulator deteriorated	2	Suggest replacement of insulator.
Coil spring insulator missing	2	Suggest replacement of insulator.
Coil spring insulator split	2	Suggest replacement of insulator.
Coil spring plastic coating deteriorated - rust present	A	(2) Refer to manufacturer's service requirements.
Composite spring damaged	..	(3) Further inspection required.
Cracked (all springs except composite leaf and secondary leave(s) on multi-leaf springs)	A	Require replacement.
Installed incorrectly	B	Require repair.
Leaf spring insulators missing	2	Suggest replacement of insulators.
Secondary leaf on multi-leaf spring broken	1	Suggest repair or replacement
Secondary leaf on multi-leaf spring cracked	1	Suggest repair or replacement
Torsion bar		

adjuster bent	A	(4) Require repair or replacement of adjuster.
Torsion bar adjuster seized	A	(4) Require repair or replacement of adjuster.
Torsion bar adjuster threads damaged	A	(4) Require repair or replacement of part with damaged threads.
Torsion bar adjuster threads stripped (threads missing)	A	Require replacement of part with stripped threads.
Vehicle suspension height not within OEM specifications	B	Require adjustment or replacement.

(1) - If vehicle is within manufacturer's height specifications, no service is suggested or required.
(2) - Some manufacturers require replacement under these conditions.
(3) - Check vehicle ride height. If ride height is OK, no service is suggested or required.
(4) - Only required if ride height needs to be adjusted.

STEEL POWER STEERING LINES

CAUTION: When replacing steel power steering lines, be sure to use a replacement product that meets or exceeds OEM design specifications.

STEEL POWER STEERING LINE INSPECTION

Condition	Code	Procedure
Attaching hardware bent	B	Require repair or replacement of bent part.
Attaching hardware broken	A	Require replacement of broken part.
Attaching hardware loose	A	Require repair or replacement of loose part.
Attaching hardware missing	C	Require replacement of missing part.
Attaching hardware threads damaged	A	Require repair or replacement of part with damaged threads.
Attaching hardware threads stripped (threads missing)	A	Require replacement of part with stripped threads.
Blocked	A	Require repair or replacement.
Fitting incorrect (such as compression fitting)	B	Require replacement.
Flare type incorrect	B	Required replacement.
Leaking	A	Require tightening or replacement.
Line type incorrect	B	Require replacement.

Restricted	A		Require replacement.
Routed incorrectly	B		Require routing correction.
Rust-pitted	1		Suggest replacement.
Rust pitted, affecting structural integrity	A		Require replacement.

STEERING ARMS

STEERING ARM INSPECTION

Condition	Code	Procedure
Attaching hardware bent	B	Require repair or replacement of bent part.
Attaching hardware broken	A	Require replacement of broken part.
Attaching hardware incorrect	A	Require replacement of incorrect part.
Attaching hardware loose	A	Require repair or replacement of loose part.
Attaching hardware missing	C	Require replacement of missing part.
Attaching hardware threads damaged	A	Require repair or replacement of part with damaged threads.
Attaching hardware threads stripped (threads missing)	A	Require replacement of part with stripped threads.
Bent	B	Require replacement.
Broken	A	Require replacement.
Taper hole elongated	A	(1) Require replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.

(1) - Check for damaged stud.

STEERING DAMPERS

The following procedures are only required if the vehicle was originally equipped from the factory with a steering damper. If the steering damper is an add-on unit, then the unit may be removed instead of repairing or replacing.

STEERING DAMPER INSPECTION

Condition	Code	Procedure
Attaching hardware bent	B	Require repair or replacement of bent part, if available; otherwise, replace steering damper.
Attaching hardware broken	A	Require replacement of broken part, if available; otherwise,

		replace steering damper.
Attaching hardware corroded, affecting structural integrity	A	Require replacement of corroded part, if available; otherwise, replace steering damper.
Attaching hardware incorrect	A	Require replacement of incorrect part, if available; otherwise, replace steering damper.
Attaching hardware loose	A	Require repair or replacement of loose part, if available; otherwise, replace steering damper.
Attaching hardware missing	C	Require replacement of missing part, if available; otherwise, replace steering damper.
Attaching hardware threads damaged	A	Require repair or replacement of part with damaged threads, if available; otherwise, replace steering damper.
Attaching hardware threads stripped (threads missing)	A	Require replacement of part with stripped threads, if available; otherwise, replace steering damper.
Binding	A	Require replacement.
Damper body dented	A	(1) Further inspection required.
Damper body punctured	A	Require replacement.
Damping (none)	A	Require replacement.
Dust boot (bellows) missing	2	(2) Suggest replacement of boot.
Dust boot (bellows) split	2	(2) Suggest replacement of boot.
Dust shield broken	2	(2) Suggest replacement.
Dust shield missing	2	(2) Suggest replacement.
Leaking oil, enough for fluid to be running down the body	A	Require replacement.
Loose	A	Require repair or replacement.
Missing	C	Require replacement.
Noise	2	(3) Further inspection required.
Piston rod bent	A	Require replacement.
Piston rod broken	A	Require replacement.
Piston rod has surface defect	2	Suggest replacement.
Piston rod threads stripped (threads missing)	A	Require replacement.
Piston rod threads damaged	A	Require repair or replacement.
Seized	A	Require replacement.

(1) - Require replacement of units where dents restrict damper

piston rod movement. If dents don't restrict movement, no service is suggested or required. Especially critical on mono-tube dampers.

(2) - This condition can lead to damage of the piston rod, which, in turn, causes premature piston rod seal wear.

(3) - If noise is isolated to damper, suggest replacement.

STEERING GEARS (EXCEPT RACK AND PINION)

If diagnosis has determined that complete disassembly is necessary to determine the extent of the system failure, the suggestion may be made to rebuild or replace the power steering pump. Repair or replacement of the following components may be required, if performed as part of a power steering pump overhaul or rebuild service to meet a minimum rebuild standard.

STEERING GEAR (EXCEPT RACK AND PINION) INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require replacement of broken part.
Attaching hardware loose	A	Require repair or replacement of loose part.
Attaching hardware missing	C	Require replacement of missing part.
Attaching hardware threads damaged	A	Require repair or replacement of part with damaged threads.
Attaching hardware threads stripped (threads missing)	A	Require replacement of part with stripped threads.
Binding	A	Require repair or replacement
Flex coupler binding	A	Require repair or replacement of coupler.
Flex coupler loose	A	Require repair or replacement of coupler.
Flex coupler missing parts	A	Require repair or replacement of coupler.
Flex coupler soft/spongy	A	Require replacement of coupler.
Flex coupler torn	A	Require replacement of coupler.
Fluid contaminated	B	(1) Require flushing and refilling of the system.
Gasket leaking	A	Require repair or replacement of gasket.
Housing leaking	A	Require replacement.
Hydraulic fittings leaking	A	Require repair or replacement of fittings.
Inadequate power assist	A	(2) Further inspection required. See note below.
Lash exceeds manufacturer's specifications	B	Require repair or replacement.
Seal leaking	A	Require repair or replacement

		of seal and/or mating part.
Splines damaged	A	Require repair or replacement of splines.
Splines stripped	A	Require replacement of splines.
Steering coupler shield cracked	2	Suggest replacement.
Steering coupler shield missing	C	Require replacement.
Threads damaged	A	Require repair or replacement of part with damaged threads.
Threads stripped (threads missing)	A	Require replacement of part with stripped threads.
U-joint binding	A	Require repair or replacement of joint.
U-joint loose	A	Require repair or replacement of joint.
Unequal power assist	A	Require repair or replacement.

(1) - Determine and correct source of contamination. OEM specifications must be followed for fluid type.
(2) - If steering gear is source of inadequate assist, require repair or replacement.

STEERING GEARS - RACK AND PINION

If diagnosis has determined that complete disassembly is necessary to determine the extent of the system failure, the suggestion may be made to rebuild or replace the power steering pump. Repair or replacement of the following components may be required, if performed as part of a power steering pump overhaul or rebuild service to meet a minimum rebuild standard.

STEERING GEARS - RACK AND PINION INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require replacement of broken part.
Attaching hardware loose	A	Require repair or replacement of loose part.
Attaching hardware missing	C	Require replacement of missing part.
Attaching hardware threads damaged	A	Require repair or replacement of part with damaged threads.
Attaching hardware threads stripped (threads missing)	A	Require replacement of part with stripped threads.
Balance tube blocked	A	Require repair or replacement of balance tube.
Balance tube missing	C	Require replacement of balance tube.
Balance tube restricted	A	Require repair or replacement of balance tube.
Bellows boot clamp missing	C	Require replacement of clamp.
Bellows boot cracked		

(not through) .... 2 .. Suggest replacement of bellows boot.
Bellows boot missing .... C .. Require replacement of bellows boot.
Bellows boot not sealing .... A ... Require repair or replacement of bellows boot.
Bellows boot torn .... A .. Require replacement of bellows boot.
Bellows boot twisted (from toe adjustment) .. B .... Require repair.
Fitting leaking .... A .. Require repair or replacement.
Fitting missing .... A . Require replacement of fitting.
Fitting threads damaged .... A ... Require repair or replacement of part with damaged threads.
Fitting threads stripped (threads missing) ...... A ..... Require replacement of part with stripped threads.
Flex coupler binding .... A ... Require repair or replacement of coupler.
Flex coupler loose ...... A ... Require repair or replacement of coupler.
Flex coupler missing parts .... A ... Require repair or replacement of coupler.
Flex coupler soft/spongy .... A . Require replacement of coupler.
Flex coupler torn .... A . Require replacement of coupler.
Fluid contaminated ...... B .... (1) Require flushing and refilling of the system.
Gasket leaking .... A .. Require repair or replacement.
Hard steering on cold start-up .... 1 .... (2) Suggest repair or replacement.
Housing cracked, affecting structural integrity .... B .... Require replacement.
Housing leaking .... A .... Require replacement.
Inadequate power assist . A .... (3) Further inspection required.
Lash exceeds manufacturer's specifications .... B .. Require repair or replacement.
Seal leaking .... A .. Require repair or replacement.
Splines damaged .... A .. Require repair or replacement.
Splines stripped (splines missing) ...... A .... Require replacement.
Steel line blocked ...... A ... Require repair or replacement of line.
Steel line leaking ...... A ... Require repair or replacement of line.
Steel line missing ...... C .... Require replacement of line.
Steel line restricted ... A ... Require repair or replacement of line.
Steering coupler shield cracked .... 2 .... Suggest replacement.
Steering coupler shield missing .... C .... Require replacement.
Steering coupler shield torn .... 2 .... Suggest replacement.
Threads damaged .... A ... Require repair or replacement of part with damaged threads.

Threads stripped (threads missing)	A	Require replacement of part with stripped threads.
U-joint binding	A	Require repair or replacement of joint.
U-joint loose	A	Require repair or replacement of joint.
Unequal power assist	A	Require repair or replacement.

(1) - Determine and correct source of contamination. Follow OE specifications for fluid type.
(2) - Indicates internal wear.
(3) - If steering gear is source of inadequate assist, require repair or replacement.

STEERING KNUCKLES

STEERING KNUCKLE INSPECTION

Condition	Code	Procedure
Attaching hardware bent	B	Require repair or replacement of bent part.
Attaching hardware broken	A	Require replacement of broken part.
Attaching hardware incorrect	A	Require replacement of incorrect part.
Attaching hardware loose	A	Require repair or replacement of loose part.
Attaching hardware missing	C	Require replacement of missing part.
Attaching hardware threads damaged	A	Require repair or replacement of part with damaged threads.
Attaching hardware threads stripped (threads missing)	A	Require replacement of part with stripped threads.
Bent	B	Require replacement.
Broken	A	Require replacement.
Pinch bolt incorrect	B	Require replacement with bolt that meets OE design.
Pinch bolt loose	B	Require repair.
Pinch bolt missing	B	Require replacement.
Pinch bolt tabs deformed (pinched together), .032" or more before clamping	B	(1) Require replacement.
Taper hole elongated	A	(2) Require replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require repair or replacement.

(1) - Steering knuckle deformation can cause pinch bolt breakage.
(2) - Check for damaged stud.

STRIKE OUT BUMPERS

STRIKE OUT BUMPER INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require replacement of broken part.
Attaching hardware corroded, affecting structural integrity	A	Require replacement of corroded part.
Attaching hardware loose	A	Require repair or replacement of loose part.
Attaching hardware missing	C	Require replacement of missing part.
Attaching hardware threads damaged	A	Require repair or replacement of part with damaged threads.
Attaching hardware threads stripped (threads missing)	A	Require replacement of part with stripped threads.
Missing	C	Require replacement.
Split	1	Suggest replacement.

STRUT RODS

STRUT ROD INSPECTION

Condition	Code	Procedure
Adjusting nut seized	A	(1) Require repair or replacement.
Attaching hardware bent	B	Require repair or replacement of bent part, if available; otherwise, replace strut rod.
Attaching hardware broken	A	Require replacement of broken part, if available; otherwise, replace strut rod.
Attaching hardware incorrect	A	Require replacement of incorrect part, if available; otherwise, replace strut rod.
Attaching hardware loose	A	Require repair or replacement of loose part, if available; otherwise, replace strut rod.
Attaching hardware missing	C	Require replacement of missing part, if available; otherwise, replace strut rod.
Attaching hardware threads damaged	A	Require repair or replacement of part with damaged threads,

		if available; otherwise, replace strut rod.
Attaching hardware threads stripped (threads missing)	A	..... Require replacement of part with stripped threads, if available; otherwise, replace strut rod.
Attaching (mating) hole oversized	A	... Require repair or replacement of frame.
Attaching point on frame corroded, affecting structural integrity ...	A	.... Require repair of frame.
Bent	A	.... Require replacement.
Mating (attaching) hole oversized	A	... Require repair or replacement of frame.
Threads damaged	A	.. Require repair or replacement.
Threads stripped (threads missing)	A	.... Require replacement.

(1) - Only required if an alignment is being performed.

STRUT UPPER BEARING PLATE ASSEMBLIES

NOTE: When the following guidelines indicate replacement of bearing, only the bearing should be replaced if it is available separately; otherwise, replace the bearing plate assembly.

STRUT UPPER BEARING PLATE ASSEMBLY INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	... Require replacement of broken part, if available; otherwise, replace bearing plate assembly.
Attaching hardware loose	A	... Require repair or replacement of loose part, if available; otherwise, replace bearing plate assembly.
Attaching hardware missing	C	.. Require replacement of missing part, if available; otherwise, replace bearing plate assembly.
Attaching hardware threads damaged	A	... Require repair or replacement of part with damaged threads, if available; otherwise, replace bearing plate assembly.
Attaching hardware threads stripped (threads missing)	A	..... Require replacement of part with stripped threads, if available; otherwise, replace bearing plate assembly.
Bearing axial or radial movement exceeds vehicle manufacturer's		

specifications	B	Require replacement of bearing.
Bearing binding	A	Require replacement of bearing.
Bearing missing	C	Require replacement of bearing.
Bearing seized	A	Require replacement of bearing.
Bent	B	Require replacement.
Holes distorted	A	Require replacement.
Missing	C	Require replacement.
Severely corroded, affecting structural integrity	A	Require replacement.

SWAY BAR LINKS

SWAY BAR LINK INSPECTION

Condition	Code	Procedure
Attaching hardware incorrect	A	Require replacement of incorrect part, if available; otherwise, replace link.
Attaching hardware loose	A	Require repair or replacement of loose part, if available; otherwise, replace link.
Attaching hardware missing	C	Require replacement of missing part, if available; otherwise, replace link.
Attaching hardware threads damaged	A	Require repair or replacement of part with damaged threads, if available; otherwise, replace link.
Attaching hardware threads stripped (threads missing)	A	Require replacement of part with stripped threads, if available; otherwise, replace link.
Ball and socket has looseness (perceptible vertical movement)	1	(1) Suggest replacement.
Ball and socket has looseness that is excessive	B	(1)(2) Require replacement.
Bent	B	Require replacement.
Broken	A	Require replacement.
Corroded, affecting structural integrity	A	Require replacement.
Grease boot cracked	2	(3) Suggest replacement.
Grease boot missing	2	(4) Suggest replacement.
Grease boot torn	2	(5) Suggest replacement.
Missing	C	Require replacement.
Nut on stud loose	A	(6) Require repair.
Stud bent	B	(7) Require replacement.
Stud broken	A	(7) Require replacement.
Threads damaged	A	Require repair or replacement.

Threads stripped (threads missing)	A	(7) Require replacement.

(1) - If manufacturer's procedures for inspection exist, use those procedures; otherwise, use an approved inspection method such as the dry park check.

CAUTION: DO NOT use pliers or pry bar to check ball and socket movement. Use only moderate hand pressure.

(2) - Excessive looseness is defined as being significant enough to affect vehicle handling or structural integrity.

(3) - Cracked grease boot will allow contaminants to enter the joint and will accelerate wear.

(4) - Lack of grease boot will allow contaminants to enter the joint and will accelerate wear.

(5) - Torn grease boot will allow contaminants to enter the joint and will accelerate wear.

(6) - Check for bent stud or damaged taper hole.

(7) - Check for damaged taper hole.

SWAY BARS

SWAY BAR INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require replacement of broken part, if available; otherwise, replace sway bar.
Attaching hardware corroded, affecting structural integrity	A	Require replacement of corroded part, if available; otherwise, replace sway bar.
Attaching hardware loose	A	Require repair or replacement of loose part, if available; otherwise, replace sway bar.
Attaching hardware missing	C	Require replacement of missing part, if available; otherwise, replace sway bar.
Attaching hardware threads damaged	A	Require repair or replacement of part with damaged threads, if available; otherwise, replace sway bar.
Attaching hardware threads stripped (threads missing)	A	Require replacement of part with stripped threads, if available; otherwise, replace sway bar.
Bent	B	Require replacement.
Broken	A	Require replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.

TIE ROD ENDS (INNER AND OUTER)

TIE ROD END (INNER AND OUTER) INSPECTION

Condition	Code	Procedure
Attaching hardware incorrect	A	Require replacement of incorrect part, if available; otherwise, replace tie rod end.
Attaching hardware loose	A	Require repair or replacement of loose part, if available; otherwise, replace tie rod end.
Attaching hardware missing	C	Require replacement of missing part, if available; otherwise, replace tie rod end.
Attaching hardware threads damaged	A	Require repair or replacement of part with damaged threads, if available; otherwise, replace tie rod end.
Attaching hardware threads stripped (threads missing)	A	Require replacement of part with stripped threads, if available; otherwise, replace tie rod end.
Adjusting sleeve bent	B	Require replacement of sleeve or tie rod end.
Adjusting sleeve clamps out of position	B	Require repair.
Adjusting sleeve corroded, affecting structural integrity	A	Require replacement of sleeve or tie rod end.
Adjusting sleeve missing	C	Require replacement of sleeve or tie rod end.
Adjusting sleeve seized	A	(1) Require repair or replacement.
Adjusting sleeve threads damaged	A	Require repair or replacement of sleeve or tie rod end.
Adjusting sleeve threads stripped (threads missing)	A	Require replacement of sleeve or tie rod end.
Binding	A	(2) Further inspection required.
Grease boot cracked	2	(3) Suggest replacement.
Grease boot missing	2	(4) Suggest replacement.
Grease boot torn	2	(5) Suggest replacement.
Grease fitting broken	A	Require replacement of grease fitting.
Grease fitting missing	C	Require replacement of grease fitting.
Grease fitting won’t seal	A	Require replacement of grease fitting.
Grease seal missing	2	(4) Suggest replacement of seal.

Grease seal torn	2	.... (5) Suggest replacement of seal.
Greaseable tie rod end won't take grease	2	...... (6) Suggest replacement of grease fitting.
Looseness (perceptible horizontal movement) ...	1	.... (7) Suggest replacement.
Looseness exceeds manufacturer's specifications	B	.... Require replacement.
Looseness that is excessive	B	..... (7)(8) Require replacement.
Nut on stud loose	A	.... (9) Require repair or replacement of nut.
Seized	A	.... Require replacement
Stud bent	B	.... (10) Require replacement.
Stud broken	A	.... (10) Require replacement.
Threads damaged	A	.. Require repair or replacement.
Threads stripped (threads missing)	A	.... (10) Require replacement.

(1) - Only required if toe needs to be adjusted.
(2) - If greaseable, grease joint. If problem persists or joint is non-greaseable, require replacement.
(3) - Cracked grease boot will allow contaminants to enter joint and will accelerate wear.
(4) - Lack of grease boot will allow contaminants to enter joint and will accelerate wear.
(5) - Torn grease boot will allow contaminants to enter joint and will accelerate wear.
(6) - If greaseable tie rod end will not take grease after replacing the grease fitting, suggest replacement of tie rod end.
(7) - If manufacturer's procedures for inspection exist, use those procedures; otherwise, use an approved inspection method such as the dry park check.
CAUTION: DO NOT use pliers or pry bar to check ball and socket movement. Use only moderate hand pressure.
(8) - Excessive looseness is defined as being significant enough to affect vehicle handling or structural integrity.
(9) - Check for bent stud or damaged taper hole.
(10) - Check for damaged taper hole.

TRACK BARS

TRACK BAR INSPECTION

Condition	Code	Procedure
Attaching hardware incorrect	A	.... Require replacement of incorrect part, if available; otherwise, replace track bar.
Attaching hardware loose	A	... Require repair or replacement of loose part, if available; otherwise, replace track bar.
Attaching hardware missing	C	.. Require replacement of missing part, if available; otherwise, replace track bar.
Attaching hardware		

threads damaged	A	Require repair or replacement of part with damaged threads, if available; otherwise, replace track bar.
Attaching hardware threads stripped (threads missing)	A	Require replacement of part with stripped threads, if available; otherwise, replace track bar.
Bent	B	Require replacement.
Corroded, affecting structural integrity	A	Require replacement.
Grease boot cracked	2	(1) Suggest replacement.
Grease boot missing	2	(2) Suggest replacement.
Grease boot torn	2	(3) Suggest replacement.
Holes distorted	A	Require replacement.
Looseness (perceptible horizontal movement)	1	(4) Suggest replacement.
Looseness that is excessive	B	(4)(5) Require replacement.
Nut on stud loose	A	(6) Require repair or replacement of nut.
Seized	A	Require replacement.
Stud bent	B	(7) Require replacement.
Stud broken	A	(7) Require replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	(7) Require replacement.
Wear exceeds manufacturer's specifications	B	Require replacement.

(1) - Cracked grease boot will allow contaminants to enter joint and will accelerate wear.
(2) - Lack of grease boot will allow contaminants to enter joint and will accelerate wear.
(3) - Torn grease boot will allow contaminants to enter joint and will accelerate wear.
(4) - If manufacturer's procedures for inspection exist, use those procedures; otherwise, use an approved inspection method such as the dry park check.
CAUTION: DO NOT use pliers or pry bar to check ball and socket movement. Use only moderate hand pressure.
(5) - Excessive looseness is defined as being significant enough to affect vehicle handling or structural integrity.
(6) - Check for bent stud or damaged taper hole.
(7) - Check for damaged taper hole.

TRAILING ARMS

TRAILING ARM INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require replacement of broken part, if available; otherwise, replace trailing arm.
Attaching hardware loose	A	Require repair or replacement of loose part, if available;

Condition	Code	Procedure
		otherwise, replace trailing arm.
Attaching hardware missing	C	Require replacement of missing part, if available; otherwise, replace trailing arm.
Attaching hardware threads damaged	A	Require repair or replacement of part with damaged threads, if available; otherwise, replace trailing arm.
Attaching hardware threads stripped (threads missing)	A	Require replacement of part with stripped threads, if available; otherwise, replace trailing arm.
Bent	B	Require replacement.
Bushing hole oversized	B	Require replacement.
Corroded, affecting structural integrity	A	Require replacement.
Holes distorted	A	Require replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.

WHEEL BEARINGS, RACES AND SEALS

NOTE: When replacing or repacking wheel bearings, grease seal replacement is required. You are not required to replace these components in axle sets. Determine the need to replace based upon the individual component conditions that follow.

WHEEL BEARING, RACE AND SEAL INSPECTION

Condition	Code	Procedure
Rear axle seal on rear-wheel drive leaking	A	Require replacement of seal and inspection of axle, bearing, housing, and vent tube.
Seal bent	1	Suggest replacement.
Seal leaking	A	Require replacement of seal and inspection of bearings.
Seal missing	C	Require replacement.
Seal torn	A	Require replacement.
Wheel bearing assembly feels rough when rotated	A	Require replacement of bearing assembly.
Wheel bearing balls are pitted	A	Require replacement of bearing assembly.
Wheel bearing balls are worn	A	Require replacement of bearing assembly.
Wheel bearing end-play exceeds vehicle manufacturer's specifications	B	Require adjustment of bearing,

		if possible. If proper adjustment cannot be obtained, require repair or replacement of worn component.
Wheel bearing race is loose in the hub bore	A	Require replacement of hub assembly and wheel bearings.
Wheel bearing races are pitted	A	Require replacement of bearing assembly.
Wheel bearing races are worn	A	Require replacement of bearing assembly.
Wheel bearing rollers are pitted	A	Require replacement of bearing assembly.
Wheel bearing rollers are worn	A	Require replacement of bearing assembly.

WHEEL ALIGNMENT

WHEEL ALIGNMENT

Wheel alignment is defined as the measurement, analysis, and adjustment of steering and suspension angles to conform to OEM specifications. These angles usually include, but are not limited to: caster, camber, toe, and thrust angle. Where these angles are not adjustable and not in specification, component replacement or correction kits may be required. Errors in set-back and steering axis inclination (SAI) are often attributable to failed or damaged components and must be corrected prior to performing an alignment.

Failure to replace or correct suggested parts or service may prevent a proper alignment.

Before performing an alignment check, inspect and verify the following:

* Tire pressure and size
* Vehicle loading
* Ride height
* Steering and suspension parts

If the inspection reveals that all the above are within published specifications, a wheel alignment check and an alignment, if needed, may be performed.

CAUTION: Under no circumstances should a technician bend or heat any steering or suspension component, unless specified by the vehicle manufacturer, for example, Ford forged twin "I" beam axles. All measurements and specifications must be noted on the inspection report.

WHEEL ALIGNMENT INSPECTION

Condition	Code	Procedure
Dog tracking, shown to be caused by faulty alignment	2	Suggest repair.
Lead, shown to		

be caused by faulty alignment	A	Require alignment.
Part has been changed, affecting alignment	A	Require alignment check.
Pull, shown to be caused by faulty alignment	A	Require alignment.
Steering wheel off-center	2	Suggest alignment.
Tire wear, shown to be caused by faulty alignment	A	Require alignment.
Wander, shown to be caused by faulty alignment	A	Require alignment.

WHEELS AND TIRES

TIRES

These guidelines do not apply to split rims. Some vehicle manufacturers restrict replacement of tires to specific brands, types, or sizes.

WARNING: High pressure temporary compact spare tires should not be used with any other rims or wheels, nor should standard tires, snow tires, wheel covers, or trim rings be used with high pressure compact spare rims or wheels. Attempting to mount a tire of one diameter on a wheel of a different diameter or flange type may result in serious injury or death.

WARNING: Only specially trained persons should dismount or mount tires. Explosions of tire and wheel assembly can result from improper mounting, possibly causing serious injury or death.

WARNING: Consult the vehicle owner's manual or vehicle placard for correct size, speed rating, designation, and cold inflation pressure of the original tires. DO NOT exceed the maximum load or inflation capacity of the tire specified by the Tire and Rim Association

WARNING: When replacing tires, it is suggested that the replacement tires match or exceed the OEM speed rating designation. If tires of different speed rating designations are mixed on the same vehicle, the tires may vary in handling characteristics. DO NOT mix different speed rating designations on the same axle.

WARNING: DO NOT mix radials with non-radial tires on the same axle, as this may affect vehicle handling and stability. If radial tires and bias or bias-belted ply tires are mixed on the same vehicle, the radials must be on the rear. High-pressure temporary compact spare tires are exempt from this rule.

WARNING: DO NOT mix size or type (all season, performance, mud and snow) of tires on the same axle.

TIRE INSPECTION

Condition	Code	Procedure
Air pressure incorrect	B	Require repair
Bead broken	A	Require replacement.
Bead leaking, caused by tire	A	Require repair or replacement.
Bead wire/cord exposed	A	Require replacement.
Cord or belt material exposed	A	Require replacement.
Cord ply separations	A	Require replacement.
Directional/asymmetrical tires mounted incorrectly	B	Require remounting and/or repositioning.
Irregular tread wear, affecting performance	2	(1) Suggest replacement.
Load ratings less than OEM specifications	B	Require replacement.
Mixed tread types (all season, performance, mud and snow) on same axle	A	Require replacement.
Number of punctures exceeds manufacturer's limit	B	Require replacement.
Out of balance	B	Require rebalance of tire/wheel assembly.
Ply separation	A	Require replacement.
Pull or lead, caused by tire	A	Require repair or replacement.
Radial and bias or bias-belted ply tires on same axle	B	Require repair or replacement.
Radials are on the front and not on the rear	B	(2) Require repair or replacement.
Run flat damage	A	Require replacement.
Shoulder cut	A	Require replacement.
Shoulder puncture	A	Require replacement.
Shoulder with plug	A	Require replacement.
Sidewall bulge	A	Require replacement.
Sidewall cut	A	Require replacement.
Sidewall indentation	..	No service required or suggested.
Sidewall puncture	A	Require replacement.
Sidewall with plug	A	Require replacement.
Speed rating designations different on same axle	2	Suggest repair or replacement.
Tire and wheel assembly has excessive run-out	B	(3) Require repair or replacement of appropriate part.
Tires with more than 1/4" diameter difference on a four-wheel drive vehicle	B	Require replacement.
Tread area puncture larger in diameter than manufacturer's specifications	B	Require replacement.
Tread missing pieces		

(chunking), exposing cord	A	Require replacement.
Tread missing pieces (chunking), not exposing cord	1	Suggest replacement.
Tread separations	A	Require replacement.
Tube in tubeless tire	3	(4) Suggest removal of tube.
Weather-checking	..	No service required or suggested.
Worn to tread wear indicators	B	Require replacement.

(1) - Determine and correct cause of irregular tire wear.
(2) - If radials and bias or bias-belted ply tires are on the same vehicle, the radials must be on the rear axle, except for high-pressure temporary spares.
(3) - Excessive is defined as enough to contribute to performance problems. Match mounting may correct run-out. If not, require replacement of appropriate part. Refer to manufacturer's specifications.
(4) - Most manufacturers do not recommend tubes in tubeless tires. Inspect tire and wheel assembly to determine the reason for a tube in tubeless tire. Recommendation for repair or replacement should be based upon condition of tires and/or wheel listed in these guidelines.

VALVE STEMS

VALVE STEM INSPECTION

Condition	Code	Procedure
Bent	1	Suggest replacement.
Broken	A	Require replacement.
Cut, but not leaking	1	Suggest replacement.
Deteriorated (cracking, dry rot)	1	Suggest replacement.
Leaking	A	Require repair or replacement.
Missing	C	Require replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped	A	Require replacement.
Valve cap missing	C	Require replacement of cap.
Weather-checking	1	Suggest replacement.
Won't take air	A	Require repair or replacement.

WHEEL ATTACHMENT HARDWARE

For conditions noted below, also check conditions of wheel stud holes.

CAUTION: Proper lug nut torque is essential. Follow recommended torque specifications and tightening sequence. DO NOT lubricate threads unless specified by the vehicle manufacturer.

WHEEL ATTACHMENT HARDWARE INSPECTION

Condition	Code	Procedure
Bent	A	Require replacement.
Broken	A	(1) Require replacement.

Loose	B	... Require repair or replacement of affected component.
Lug nut installed backward	B	.. Require repair or replacement.
Lug nut mating type incorrect	B	..... Require replacement of nut.
Lug nut mating surface dished	A	..... Require replacement of nut.
Lug nut rounded	A	. (2) Require replacement of nut.
Lug nut seized	A	. (2) Require replacement of nut.
Stud incorrect	B	.... Require replacement of stud.
Threads damaged	A	... Require repair or replacement of component with damaged threads.
Threads stripped	A	.... Require replacement of component with stripped threads.

(1) - Some manufacturers require replacement of all studs on that wheel if two or more studs or nuts on the same wheel are broken or missing.
(2) - Only required if removing wheel.

WHEELS (RIMS)

WARNING: Mounting a regular tire on a high-pressure compact spare wheel is not permitted. Attempting to mount a tire of one diameter on a wheel of a different diameter or flange type may result in serious injury or death. If the wheel identification stamp is not legible, or cannot be found, do not use the wheel until the size and type have been properly identified. Wheels of different diameter, offset, or width cannot be mixed on the same axle. Bead seat tapers cannot be interchanged.

WHEEL (RIM) INSPECTION

Condition	Code	Procedure
Bead leaking, caused by wheel	A	.... (1) Require repair or replacement.
Bent hub mounting surface	A	.... Require replacement.
Bent rim, causing vibration	2	.... (1) Suggest replacement.
Broken	A	.... Require replacement.
Cast wheel porous, causing a leak	A	.. Require repair or replacement.
Clip-on balance weight is incorrect type for rim flange	2	.... Suggest replacement.
Corrosion, affecting structural integrity ...	A	.... Require replacement.
Corrosion build-up on wheel mounting surface	A	.... Require repair.
Cracked	A	.... Require replacement.
Directional/asymmetrical wheels mounted incorrectly	B	.... Require remounting and/or repositioning.

Load capacity less than OEM specifications	B	Require replacement.
Offset mismatched on same axle	B	Require replacement.
Rivets leaking	A	Require replacement.
Run-out beyond OEM specs	B	Require replacement.
Stud holes elongated	A	(2) Require replacement.
Welded or brazed repair	2	Suggest replacement.
Welds leaking	A	Require replacement.
Wheel centering (pilot) hole incorrect	B	Require replacement.

(1) - CAUTION: DO NOT attempt to correct a bent rim.
(2) - Inspect wheel attaching hardware for damage.

STEERING WHEEL & HORN REMOVAL

1988 Jeep Cherokee

1988 STEERING
Jeep Horn & Steering Wheel Removal

All Models

* PLEASE READ THIS FIRST *

NOTE: For removal and installation procedures of column mounted switches, see STEERING COLUMN SWITCHES article in the STEERING section.

REMOVAL & INSTALLATION

HORN BUTTON

Removal & Installation

1) Disconnect negative battery cable. Place wheels in straight-ahead position. On models with standard steering wheel, remove horn button retaining screws from rear of steering wheel.

2) On models with sport steering wheel, remove horn button by pulling button upward. On all models, remove horn internal components. Place components in order of removal. To install, reverse removal procedure.

STEERING WHEEL

CAUTION: Some steering wheel shaft nuts have metric threads. Metric threads have an identification groove cut perpendicular to steering wheel splines. Standard threads do not have groove.

Removal & Installation (Grand Wagoneer)

1) Remove horn button. Disconnect horn wire at steering wheel switch. Unseat horn wire and spring retainer at the canceling cam yoke. Remove wire, retainer and spring as an assembly.

2) On vehicles with sport steering wheel, remove receiver bushing retaining screws. Remove bushing, horn button receiver and contact plate. On all models, remove steering wheel retaining nut.

3) Mark steering wheel and shaft for reassembly reference. Using Steering Wheel Puller (J-21232), remove steering wheel. To install, reverse removal procedure. Align marks made during removal.

Removal & Installation (All Others)

Remove horn button. Remove steering wheel retaining nut. Mark steering wheel and shaft for reassembly reference. Using Steering Wheel Puller (J-21232), remove steering wheel. To install, reverse removal procedure. Align reference marks.

TROUBLE SHOOTING

Refer to TROUBLE SHOOTING - BASIC PROCEDURES article in the GENERAL TROUBLE SHOOTING section.

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS TABLE

Application	Ft. Lbs. (N.m)

Steering Wheel Retaining Nut	
Grand Wagoneer & Pickup	30 (41)
All Others	25 (34)

SUSPENSION - FRONT

1988 Jeep Cherokee

1988 FRONT SUSPENSION
Jeep Coil & Leaf Spring

Cherokee, Comanche, Grand Wagoneer, Wagoneer, Wrangler

DESCRIPTION

Cherokee, Comanche and Wagoneer 2WD and 4WD front suspensions consist of solid axle (tubular axle on 2WD), 4 control arms, 2 coil springs and track bar. Track bar is used to minimize front axle side-to-side movement. Stabilizer bar and shock absorbers control suspension spring movement.

Grand Wagoneer and Wrangler models use leaf spring front suspension with shock absorbers and stabilizer bar. Wrangler also uses a track bar to maintain lateral position of front and rear axles.

ADJUSTMENTS

WHEEL ALIGNMENT

See WHEEL ALIGNMENT SPECIFICATIONS & PROCEDURES in WHEEL ALIGNMENT section.

WHEEL BEARING

NOTE: Bearings should be cleaned, inspected, replaced (if necessary) and lubricated before adjustment.

CAUTION: Never preload tapered roller bearings or damage to roller ends will result. Bearings are designed to have a slightly loose feel when properly adjusted.

2WD Models

1) Raise and support vehicle. Remove wheel and tire assembly. Remove hub dust cap, cotter pin and nut retainer. Ensure bearings are thoroughly packed with lithium grease.

2) Rotate hub and rotor assembly by hand, and tighten retainer nut to 17-25 ft. lbs. (23-34 N.m) to seat bearings.

3) Loosen retainer nut 1/2 turn while rotating hub. Then retighten nut to 19 INCH lbs. (2 N.m). Install nut retainer and new cotter pin. Clean hub dust cap and coat inside with clean grease. Reverse removal procedure for remaining components.

4WD Models (Grand Wagoneer)

1) On models equipped with locking hubs, remove locking hubs. See appropriate LOCKING HUBS article. On models without locking hubs, remove hub dust cap and drive gear snap ring. See Fig. 1.

2) Remove drive gear, pressure spring and spring cup. On all models, remove outer lock nut and lock washer. Tighten inner lock nut to 50 ft. lbs. (68 N.m) while rotating wheel.

3) Back off inner lock nut 45-65 degrees while rotating wheel. Install washer and outer lock nut. Tighten outer lock nut to 50 ft. lbs. (68 N.m). Reverse removal procedure to complete installation.

REMOVAL & INSTALLATION

WHEEL BEARINGS

Removal (2WD Models)

1) Raise and support vehicle. Remove wheel assembly. Remove brake caliper. Suspend caliper with wire. DO NOT allow caliper to hang on brake hose.

2) Remove hub dust cap, cotter pin, nut retainer, retainer nut, washer and outer wheel bearing. See Fig. 1. Remove hub and rotor assembly. Pry grease seal from hub. Remove inner wheel bearing.

Inspection

Clean bearings and hub in solvent and dry with compressed air. Inspect bearings and races for wear.

Installation

To install, reverse removal procedure. Adjust wheel bearing. See WHEEL BEARING under ADJUSTMENTS in this article.

Removal
(4WD Grand Wagoneer)

1) Raise and support vehicle. Remove wheel assembly. Remove brake caliper. Suspend caliper with wire. DO NOT allow caliper to hang on brake hose. Remove rotor from hub.

2) On models equipped with locking hubs, remove locking hubs. See appropriate LOCKING HUBS article. On all other models, remove hub dust cover and drive gear snap ring. See Fig. 1.

3) Remove drive gear, pressure spring and spring cup. On all models, remove outer lock nut, lock washer, inner lock nut and outer wheel bearing. Remove hub. Pry grease seal from hub. Remove inner wheel bearing.

Inspection

Clean bearings and hub in solvent and dry with compressed air. Inspect bearings and races for wear.

Installation

To install, reverse removal procedure. Adjust wheel bearings. See WHEEL BEARINGS under ADJUSTMENTS in this article.

Removal
(4WD Models Except Grand Wagoneer)

1) Raise and support vehicle. Remove wheel assembly. Remove brake caliper. Suspend caliper with wire. Remove cotter pin, nut retainer and axle shaft nut. Remove hub/carrier assembly from steering knuckle. See Fig. 1.

2) Inspect bearings for roughness. If bearing roughness exists, disassemble hub assembly.

Inspection

Clean bearings and hub in solvent and dry with compressed air. Inspect bearings and races for wear.

Installation

Ensure hub, bearing carrier and wheel bearings are packed with clean lithium grease. Reassemble hub assembly using new grease seal. Reverse removal procedure. Tighten bolts to specification. Install new cotter pin.

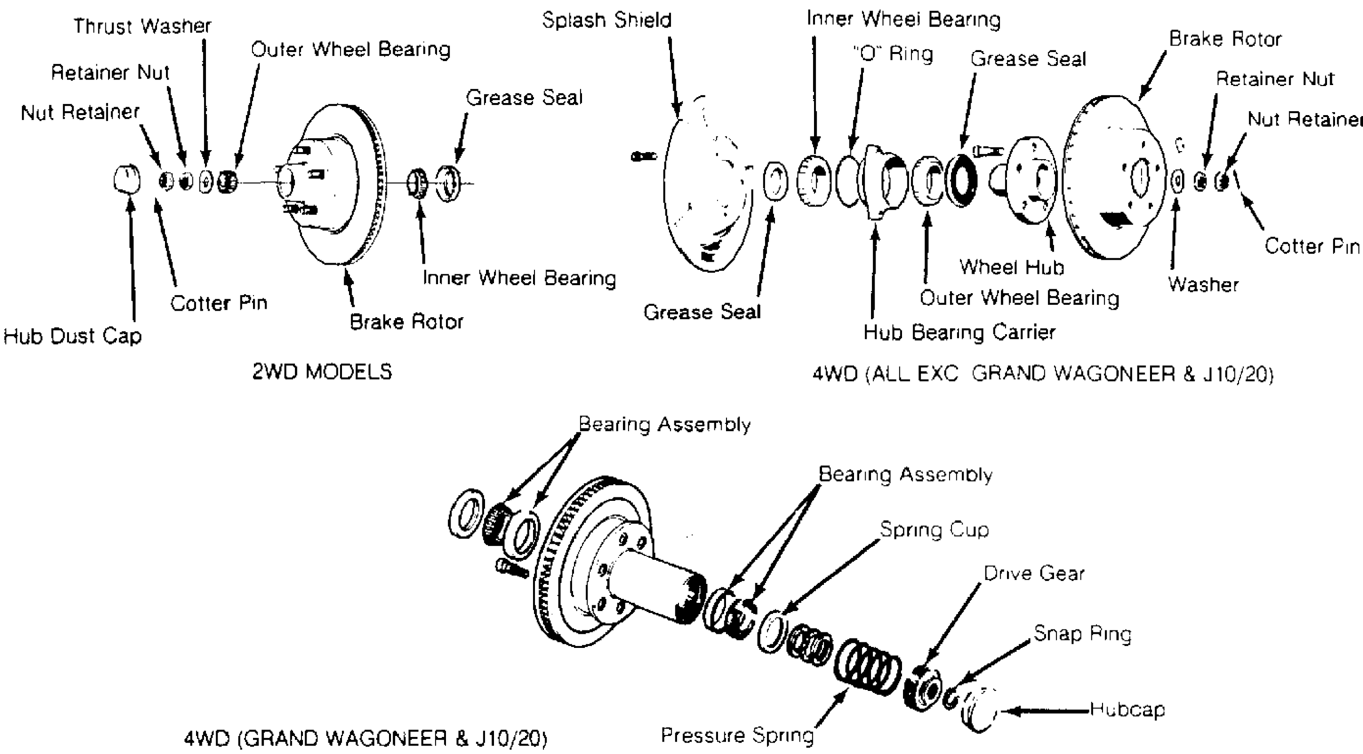


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Fig. 1: Exploded View Of 2WD Hub/Rotor Assembly & 4WD Hub/Bearing Carrier Assembly
Courtesy of Chrysler Motors.

SHOCK ABSORBER

Removal & Installation

1) With vehicle at normal riding height, remove nut, washer, and rubber grommet from top of shock absorber. Note component locations for reassembly reference.

2) Raise and support vehicle. Remove lower shock mounting bolts from axle housing bracket. Remove shock absorber. Inspect units for damage or leakage. Replace shock absorbers in pairs only. To install, reverse removal procedure.

STEERING KNUCKLE

Removal

1) Raise and support vehicle. Remove wheel assembly. Remove brake caliper. Suspend caliper with wire. Remove brake rotor or hub/bearing carrier assembly. See WHEEL BEARINGS in this article.

2) Remove axle shaft from left side of axle housing. To remove right axle shaft, disconnect vacuum harness from shift motor. Remove shift motor and axle shaft from housing. Remove caliper anchor plate from steering knuckle.

3) On each steering knuckle, remove ball joint stud cotter pin and retaining nuts. Using brass hammer, strike steering knuckle at ball joint stud bore area to loosen ball joint from steering knuckle.

4) Inspect split ring seat in steering knuckle ball joint stud bore for damage. If damaged, use Split Ring Seat Remover/Installer to remove split ring seat.

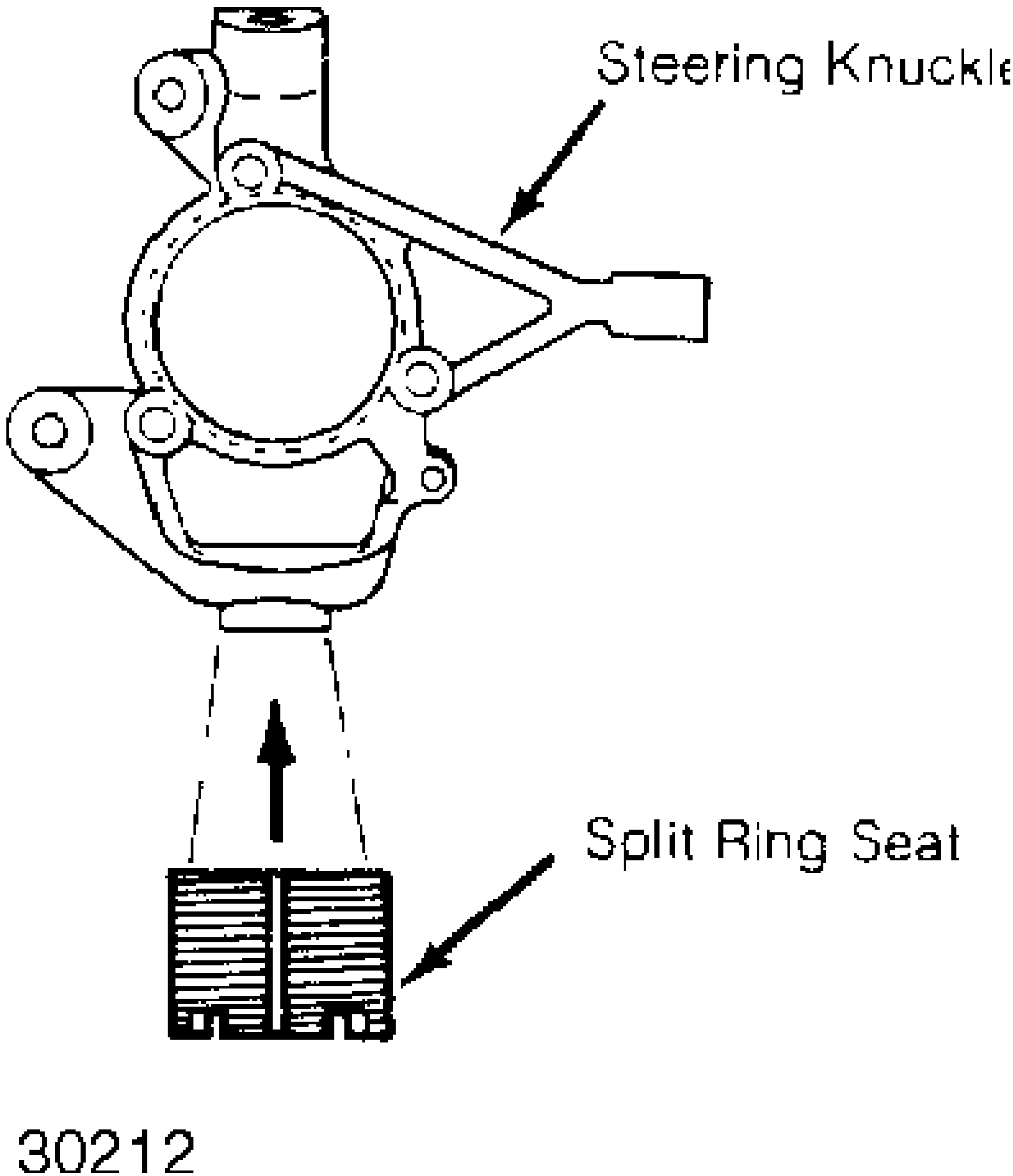

Fig. 2: Determining Steering Knuckle
Split Ring Seat Position
Courtesy of Chrysler Motors.

Installation

1) If split ring seat is replaced, ensure seat is adjusted to proper depth into steering knuckle ball joint stud bore. Using split ring seat remover /installer, install split ring seat to a depth of .206" (5.23 mm).

2) This depth is measured from steering knuckle surface to top (notched edge) of split ring seat. See Fig. 2. To install, reverse removal procedures.

3) When installing right axle shaft, ensure shift collar is positioned on intermediate shaft and axle shaft is fully engaged over intermediate shaft. Install shift motor. Ensure shift fork engages with collar. Tighten all bolts to specification.

UPPER & LOWER BALL JOINTS

Removal

1) Raise and support vehicle. Remove wheel assembly. Inspect upper and lower ball joints for damage, torn grease seals or excessive wear. Replace as necessary.

2) Remove steering knuckle assembly. See STEERING KNUCKLE in this article. Position Ball Joint Receiver (J-34503-1) over top of upper ball joint. Place Adapter (J-34503-3) in "C" Clamp (J-34503). Install "C" clamp, adapter and receiver. Tighten "C" clamp screw to remove ball joint. See Fig. 3.

3) To remove lower ball joint, position Ball Joint Receiver (J-34503-1) onto "C" Clamp (J-34503) and Adapter (J-34503-3) at base of clamp. See Fig. 3. Install "C" clamp, adapter and receiver. Tighten "C" clamp to remove ball joint. See Fig. 3.

Installation

1) Place upper ball joint in position. Position Ball Joint Installer (J-34503-3) over new upper ball joint. Install Receiver (J-34503-2) and "C" clamp. Position clamp, and receiver against axle housing bracket, over installer and ball joint. Tighten "C" clamp and fully seat ball joint. See Fig. 3.

2) To install lower ball joint, position Ball Joint Installer (J-34503-12), "C" clamp and Receiver (J-34503-4) See Fig. 3. Tighten "C" clamp to install ball joint. Ensure ball joint is fully seated. Reverse removal procedures for remaining components. Tighten bolts to specification.

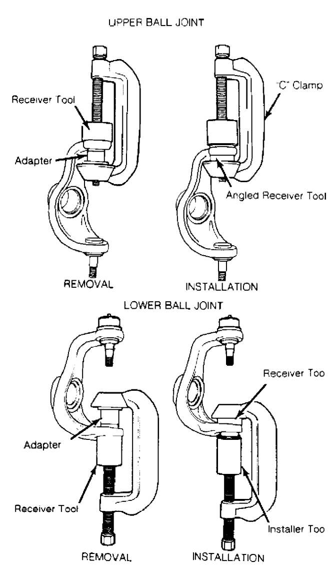

Fig. 3: Removing & Installing Upper & Lower Ball Joints
Courtesy of Chrysler Motors.

COIL SPRING

Removal

1) Raise and support vehicle. Remove wheel assembly. Place reference mark on drive shaft and front axle flange. Disconnect drive shaft at front axle. Place jack stand under axle housing. Disconnect lower control arms at axle housing.

2) Disconnect stabilizer bar links and lower shock absorber mounting bolts at axle housing. Disconnect track bar at the sill bracket (if equipped). Disconnect center link at pitman arm.

3) Lower axle housing to relieve spring pressure. Remove spring retainer mounting bolt, then remove retainer and coil spring. Note component locations for reassembly reference.

NOTE: Coil springs are rated separately for each side of vehicle depending on optional equipment and type of service. Ensure springs are marked for installation in original positions.

Installation

1) Install coil spring and spring retainer. Tighten retainer mounting bolt. Raise axle housing into position. Connect lower control arms to axle housing.

2) Install lower shock absorber mounting bolts, center link-to-pitman arm, track bar-to-frame bracket and stabilizer bar links-to-axle housing. To complete installation, reverse removal procedure.

LEAF SPRING

Removal & Installation

Raise and support vehicle. Raise axle assembly with jack to relieve spring tension. On Wrangler models, loosen stabilizer bar link nut. On all other models, remove stabilizer bar. Remove spring "U" bolts and plate. Disconnect front and rear shackles from frame. Lower spring assembly. To install, reverse removal procedure.

UPPER CONTROL ARM &

AXLE HOUSING PIVOT BUSHING

Removal

1) To remove right side upper control arm for 6-cylinder models, disconnect right side engine mount. Raise and support engine so rear control arm mounting bolt clears exhaust pipe. On all models, raise and support vehicle.

2) Remove upper control arm mounting bolt from axle housing. Disconnect control arm mounting bolt at frame rail. Remove upper control arm. Repeat procedure for opposite control arm. Inspect control arm for damage or distortion and replace as needed.

3) Check pivot bushings for excessive distortion, deterioration or wear. If bushing replacement is necessary, install Spacer (J-33581-3) between ears of control arm bracket on axle housing. See Fig. 4.

NOTE: Spacer is not used on axle housings with solid control arm brackets.

CAUTION: Do not attempt to remove upper control arm pivot bushing without spacer. Tool is designed to support bracket and prevent distortion during bushing removal.

4) Install Upper Control Arm Pivot Bushing Remover/Installer Set (J-35581, which must include Spacer J-35581-3, Remover/Installer

J-35581-2, Receiver J-35581-1, Bolt J-21474-19 and Nut J-21474-18) onto pivot bushing. See Fig. 4.

5) Rotate nut to press bushing from axle housing and into receiver. See Fig. 4. Once bushing is removed, remove bushing remover/installer set but leave spacer in position for new bushing installation.

Installation

1) Position bushing on Remover/Installer (J-35581-2) and Nut (J-21474-18). Position bushing and installer components in control arm bracket. Assemble remaining installer components. See Fig. 4.

2) Rotate nut to press bushing into housing until fully seated in bore. See Fig. 4. Remove bushing installer components. Reverse removal procedure for remaining components.

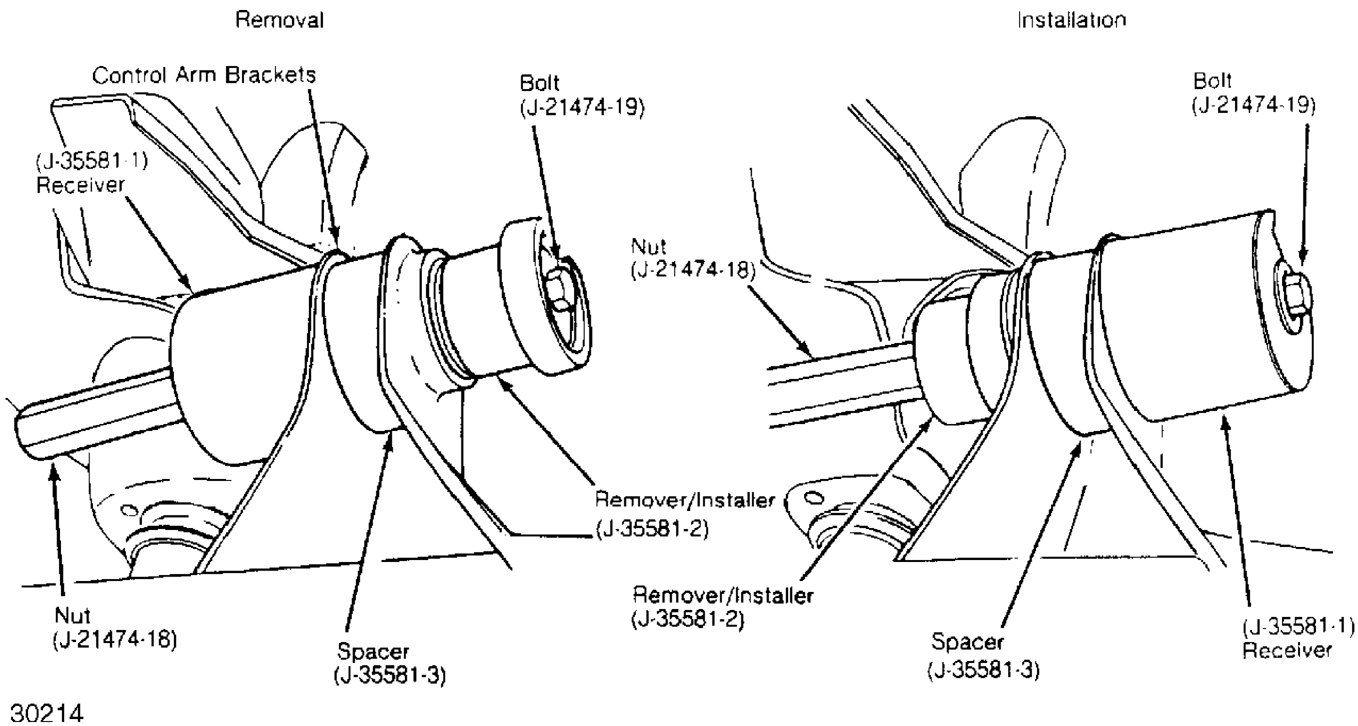

Fig. 4: Removing & Installing Upper Control Arm Bushing
Courtesy of Chrysler Motors.

LOWER CONTROL ARM & BUSHING

Removal

1) Raise and support vehicle. Disconnect lower control arm mounting bolts at axle housing and frame brackets. Remove lower control arm.

2) Inspect control arm for damage and bushings for excessive distortion or wear. Replace control arm and/or bushings as necessary.

Installation

Position lower control arm in front and rear brackets. Install mounting bolts and nuts. Tighten mounting bolts to specification.

TRACK BAR

Removal

1) Raise and support vehicle. Remove cotter pin and mounting

nut at frame rail bracket. Remove retaining bolt at axle housing bracket. Remove track bar. Inspect track bar and bushing for damage or wear. Replace as needed.

2) If a snapping noise was noted at the front of vehicle, inspect track bar bushing inner sleeve for signs of wear. If sleeve has been contacting axle bracket, spread bracket flanges approximately 1/8" to provide space for a Hardened Washer Part No. (G2436163).

Installation

1) Position track bar in axle housing bracket. Install spacer/washer between rear flange of bracket and track bar bushing. DO NOT install spacer/washer at the front of bracket.

2) Loosely install mounting bolt. Ensure mounting bolt passes through spacer/washer. Connect track bar at frame rail bracket. Tighten ball stud mounting nut-to-frame rail bracket. Tighten all bolts to specification. Install new cotter pin.

FRONT STABILIZER BAR & LINKS

Removal

1) Raise and support vehicle. Disconnect stabilizer bar from upper portion of stabilizer bar links. Note location of grommets and washers for reassembly reference.

2) Disconnect stabilizer bar from frame rail brackets. Remove stabilizer bar. Inspect bar for damage. Check rubber grommets, bushings and bracket supports for distortion and/or deterioration. Replace worn components as necessary.

3) If necessary, disconnect lower links at axle housing brackets and remove. Inspect links for damage and rubber grommets for excessive wear, distortion and/or deterioration. Replace components as necessary.

Installation

1) Lubricate stabilizer bar bushings and grommets with rubber grease. Connect links to axle housing brackets. Install washers and rubber grommets on links.

2) Install rubber bushings and brackets onto stabilizer bar and connect components to frame rails. Connect stabilizer bar to stabilizer links. Tighten mounting bolts to specification.

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS TABLE

Application	Ft. Lbs. (N.m)
Axle Shaft Nut	175 (237)
Brake Caliper Anchor Plate Bolt	70-85 (95-115)
Brake Caliper-to-Anchor Plate Pin	25-35 (34-48)
Center Link-To-Pitman Arm Nut	25-45 (34-61)
Control Arm To-Axle	
Housing Bracket Bolt	
Lower	118-148 (160-200)
Upper	48-63 (65-85)
Upper Frame Bolt	59-74 (80-100)
Drive Shaft "U" Joint Strap Bolt	12-17 (16-23)
Lug Nuts	75 (102)
Shock Absorber	
Lower Mounting Bolt	
W/Coil Springs	12-16 (16-22)

W/Leaf Springs	35-55 (48-75)
Upper Nut	
Grand Wagoneer	25-40 (34-54)
All Others	14 (19)
Spring-to-Frame Bracket Bolt	95-115 (129-156)
Spring-to-Shackle Bolt	85-105 (115-142)
Spring "U" Bolt	
9/16" x 18	85-105 (115-142)
1/2" x 20	45-65 (61-88)
Stabilizer Bar Mounting Bolt	
Grand Wagoneer	27-45 (37-61)
All Others	
Stabilizer Bar Bracket-to-Frame Rail	
W/Coil Springs	48-63 (65-85)
W/Leaf Springs	25-35 (34-48)
Stabilizer Bar Link-to-Axle Bracket Bolt	59-81 (80-110)
Stabilizer Bar Link-to-Axle Plate Nut	35-55 (48-75)
Stabilizer Bar-to-Link Bolt	35-55 (48-75)
Stabilizer Bar-to-Link Nut	
Grand Wagoneer	48-62 (65-84)
All Others	23-31 (31-42)
Steering Knuckle-to-Hub Bolt	75 (101)
Steering Knuckle-to-Ball Joint Mounting Nut	
W/Coil Springs	65-85 (88-115)
W/Leaf Springs	87-113 (118-153)
Steering Knuckle-to-Tie Rod Nut	25-45 (34-61)
Track Bar Bracket-to-Frame Rail Bolt	66-81 (90-110)
Track Bar Bracket-to-Axle Nut	66-81 (90-110)
Track Bar-to-Frame Bracket Nut	30-40 (41-54)

* SUSPENSION UNIFORM INSPECTION GUIDELINES *

1988 Jeep Cherokee

GENERAL INFORMATION
Steering, Suspension, Wheel Alignment, Wheels and Tires
Motorist Assurance Program
Standards For Automotive Repair

All Makes and Models

INTRODUCTION TO MOTORIST ASSURANCE PROGRAM (MAP)

CONTENTS

TIE ROD ENDS (INNER AND OUTER)
TRACK BARS
TRAILING ARMS
WHEEL BEARINGS, RACES AND SEALS

Wheel Alignment

WHEEL ALIGNMENT

Wheels and Tires

TIRES
VALVE STEMS
WHEEL ATTACHMENT HARDWARE
WHEELS (RIMS)

MOTORIST ASSURANCE PROGRAM (MAP)

OVERVIEW

The Motorist Assurance Program is the consumer outreach effort of the Automotive Maintenance and Repair Association, Inc. (AMRA). Participation in the Motorist Assurance Program is drawn from retailers, suppliers, independent repair facilities, vehicle manufacturers and industry associations.

Our organization's mission is to strengthen the relationship between the consumer and the auto repair industry. We produce materials that give motorists the information and encouragement to take greater responsibility for their vehicles-through proper, manufacturer-recommended, maintenance. We encourage participating service and repair shops (including franchisees and dealers) to adopt 1) a Pledge of Assurance to their Customers and 2) the Motorist Assurance Program Standards of Service. All participating service providers have agreed to subscribe to this Pledge and to adhere to the promulgated Standards of Service demonstrating to their customers that they are serious about customer satisfaction.

These Standards of Service require that an inspection of the vehicle's (problem) system be made and the results communicated to the customer according to industry standards. Given that the industry did not have such standards, the Motorist Assurance Program successfully promulgated industry inspection communication standards in 1994-95 for the following systems: Exhaust, Brakes, ABS, Steering and Suspension, Engine Maintenance and Performance, HVAC, and Electrical Systems. Further, revisions to all of these inspection communication standards are continually re-published. In addition to these, standards for Drive Train and Transmissions have recently been promulgated. Participating shops utilize these Uniform Inspection & Communication Standards as part of the inspection process and for communicating their findings to their customers.

The Motorist Assurance Program continues to work cooperatively and proactively with government agencies and consumer groups toward solutions that both benefit the customer and are mutually acceptable to both regulators and industry. We maintain the belief that industry must retain control over how we conduct our business, and we must be viewed as part of the solution and not part of the problem. Meetings with state and other government officials (and their representatives), concerned with auto repair and/or consumer protection, are conducted. Feedback from these sessions is brought back to the association, and the program adjusted as needed.

To assure auto repair customers recourse if they were not satisfied with a repair transaction, the Motorist Assurance Program offers mediation and arbitration through MAP/BBB-CARE and other non-

profit organizations. MAP conducted pilot programs in twelve states before announcing the program nationally in October, 1998. During the pilots, participating repair shops demonstrated their adherence to the Pledge and Standards and agreed to follow the UICS in communicating the results of their inspection to their customers. To put some "teeth" in the program, an accreditation requirement for shops was initiated. The requirements are stringent, and a self-policing method has been incorporated which includes the "mystery shopping" of outlets.

We welcome you to join us as we continue our outreach... with your support, both the automotive repair industry and your customers will reap the benefits. Please visit MAP at our Internet site www. motorist.org or contact us at:

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January 1999

MAP UNIFORM INSPECTION GENERAL GUIDELINES

OVERVIEW OF SERVICE REQUIREMENTS & SUGGESTIONS

It is MAP policy that all exhaust, brake, steering, suspension, wheel alignment, drive-line, engine performance and maintenance, and heating, ventilation and air conditioning, and electrical services be offered and performed under the standards and procedures specified in these sections.

Before any service is performed on a vehicle, an inspection of the appropriate system must be performed. The results of this inspection must be explained to the customer and documented on an inspection form. The condition of the vehicle and its components will indicate what services/part replacements may be "Required" or "Suggested". In addition, suggestions may be made to satisfy the requests expressed by the customer.

When a component is suggested or required to be repaired or replaced, the decision to repair or replace must be made in the customer’s best interest, and at his or her choice given the options available.

This section lists the various parts and conditions that indicate a required or suggested service or part replacement. Although this list is extensive, it is not fully inclusive. In addition to this list, a technician may make a suggestion. However, any suggestions must be based on substantial and informed experience, or the vehicle manufacturer’s recommended service interval and must be documented.

Some conditions indicate that service or part replacement is required because the part in question is no longer providing the function for which it is intended, does not meet a vehicle manufacturer’s design specification or is missing.

Example:
An exhaust pipe has corroded severely and has a hole in it through which exhaust gases are leaking. Replacement of the exhaust pipe in this case is required due to functional failure.

Example:
A brake rotor has been worn to the point where it measures less than the vehicle manufacturer’s discard specifications. Replacement of the rotor is required because it does not meet design specifications.

Some conditions indicate that a service or part replacement is suggested because the part is close to the end of its useful life or addresses a customer's need, convenience or request. If a customer's vehicle has one of these conditions, the procedure may be only to suggest service.

Example:
An exhaust pipe is rusted, corroded or weak, but no leaks are present. In this case, the exhaust pipe has not failed. However, there is evidence that the pipe may need replacement in the near future. Replacement of the pipe may be suggested for the customer's convenience in avoiding a future problem.

Example:
The customer desires improved ride and/or handling, but the vehicle's shocks or struts have not failed. In this case, replacement may be suggested to satisfy the customer's wishes. In this case, replacement of the shocks or struts may not be sold as a requirement.

A customer, of course, has the choice of whether or not a shop will service his or her vehicle. He or she may decide not to follow some of your suggestions. When a repair is required, a MAP shop must refuse partial service on that system if, in the judgment of the service provider, proceeding with the work could create or continue an unsafe condition. When a procedure states that required or suggested repair or replacement is recommended, the customer must be informed of the generally acceptable repair/replacement options whether or not performed by the shop.

When presenting suggested repairs to the customer, you must present the facts, allowing the customer to draw their own conclusions and make an informed decision about how to proceed.

The following reasons may be used for required and suggested services. These codes are shown in the "Code" column of the MAP Uniform Inspection & Communications Standards that follow:

Reasons to Require Repair or Replacement

A - Part no longer performs intended purpose
B - Part does not meet a design specification (regardless of performance)
C - Part is missing

NOTE: When a repair is required, the shop must refuse partial service to the system in question, if the repair creates or continues an unsafe condition.

Reasons to Suggest Repair or Replacement

1 - Part is close to the end of its useful life (just above discard specifications, or weak; failure likely to occur soon, etc.)
2 - To address a customer need, convenience, or request (to stiffen ride, enhance performance, eliminate noise, etc.)
3 - To comply with maintenance recommended by the vehicle's Original Equipment Manufacturer (OEM)
4 - Technician's recommendation based on substantial and informed experience

NOTE: Suggested services are always optional. When presenting suggested repairs to the customer, you must present

the facts, allowing the customer to draw their own conclusions and make an informed decision about how to proceed.

STEERING AND SUSPENSION

SERVICE PROCEDURES REQUIRED AND SUGGESTED FOR PROPER VEHICLE OPERATION

Steering and suspension are complex systems made up of a variety of interdependent components. For proper vehicle handling, ride, and tire wear, a thorough inspection is required whenever suspension work is being performed.

Conditions listed assume that the problem has been isolated to the specific component by proper testing procedures.

NOTE: When replacing steering and/or suspension components which may affect an alignment angle, you are required to check and adjust alignment as needed. Refer to the OEM specifications.

CAUTION: DO NOT use ride height altering or load compensating components, such as variable rate springs and coil over shocks, on vehicles with height or load sensing proportioning valve-equipped braking systems, unless these components are original equipment.

AIR RIDE SUSPENSION

NOTE: Depending on the air suspension design, there are some aftermarket products available to eliminate the air ride suspension on certain vehicles. If the system has been eliminated with one of these products, then no service is suggested or required.

AIR RIDE SUSPENSION - AIR SHOCKS AND AIR STRUTS

NOTE: This section covers the air spring portion of the air shock or strut. For damping portion of shock or strut conditions and procedures, refer to the SHOCK ABSORBERS, STRUT CARTRIDGES AND STRUT ASSEMBLIES section.

AIR RIDE SUSPENSION - AIR SHOCK AND AIR STRUT INSPECTION

Condition	Code	Procedure
Inner fabric of air bag damaged	A	Require replacement.
Leaking	A	Require repair or replacement.
Outer covering of air bag is cracked to the extent that inner fabric of air bag is visible	1	Suggest replacement.

AIR RIDE SUSPENSION - AIR SPRING VALVES

AIR RIDE SUSPENSION - AIR SPRING VALVE INSPECTION

Condition	Code	Procedure

Attaching hardware incorrect	A	Require replacement of incorrect part.
Attaching hardware loose	A	Require repair or replacement of loose part.
Attaching hardware missing	C	Require replacement of missing part.
Attaching hardware threads damaged	A	Require repair or replacement of part with damaged threads.
Attaching hardware threads stripped (threads missing)	A	Require replacement of part with stripped threads.
Blocked	A	Require repair or replacement.
Connector bent	A	Require repair or replacement.
Connector broken	A	Require replacement.
Connector loose	A	Require repair or replacement.
Inoperative	A	Require repair or replacement.
Leaking	A	Require repair or replacement.
Restricted	A	Require repair or replacement.

AIR RIDE SUSPENSION - AIR SPRINGS

AIR RIDE SUSPENSION - AIR SPRING INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require replacement of broken part.
Attaching hardware incorrect	A	Require replacement of incorrect part.
Attaching hardware loose	A	Require repair or replacement of loose part.
Attaching hardware missing	C	Require replacement of missing part
Attaching hardware threads damaged	A	Require repair or replacement of part with damaged threads.
Attaching hardware threads stripped (threads missing)	A	Require replacement of part with stripped threads.
Collar cracked	A	Require replacement.
End cap cracked	A	Require replacement.
Inner fabric of bag damaged	A	Require replacement.
Leaking	A	Require repair or replacement.
Outer covering of air bag is cracked to the extent that inner fabric of air bag is visible	1	Suggest replacement.
Piston cracked	A	Require replacement.

AIR RIDE SUSPENSION - COMPRESSORS

AIR RIDE SUSPENSION - COMPRESSOR INSPECTION

Condition	Code	Procedure
Attaching hardware bent	B	Require repair or replacement of bent part.
Attaching hardware broken	A	Require replacement of broken part.
Attaching hardware loose	A	Require repair or replacement of loose part.
Attaching hardware missing	C	Require replacement of missing part.
Attaching hardware threads damaged	A	Require repair or replacement of part with damaged threads.
Attaching hardware threads stripped (threads missing)	A	Require replacement of part with stripped threads.
Connector bent	A	Require repair or replacement.
Connector broken	A	Require replacement.
Connector loose	A	Require repair or replacement.
Does not build pressure	A	(1) Further inspection required.
Excessive run time	B	(2) Further inspection required.
Inoperative	A	Require replacement.
Leaking	A	Require repair or replacement.
Missing	C	Require replacement.

(1) - If failure to build pressure is traced to the compressor, require replacement.
(2) - If excessive run time is traced to the compressor, require replacement.

AIR RIDE SUSPENSION - HEIGHT SENSORS

AIR RIDE SUSPENSION - HEIGHT SENSOR INSPECTION

Condition	Code	Procedure
Attaching hardware bent	B	Require repair or replacement of bent part.
Attaching hardware broken	A	Require replacement of broken part.
Attaching hardware corroded, affecting structural integrity	A	Require replacement of corroded part.
Attaching hardware loose	A	Require repair or replacement of loose part.
Attaching hardware missing	C	Require replacement of missing part.
Attaching hardware		

threads damaged	A	Require repair or replacement of part with damaged threads.
Attaching hardware threads stripped (threads missing)	A	Require replacement of part with stripped threads.
Dust boot missing	2	(1) Suggest replacement.
Dust boot split	2	(1) Suggest replacement.
Dust boot torn	2	(1) Suggest replacement.
Housing cracked	A	Require replacement.
Lead routing incorrect	B	Require rerouting according to vehicle manufacturer's specifications.
Loose	B	Require adjustment to vehicle manufacturer's specifications.
Missing	C	Require replacement.
Output signal incorrect	A	Require repair or replacement.
Wire lead damaged	A	Require repair or replacement.

(1) - This condition can lead to damage of the sliding magnet, which, in turn, causes premature sensor failure.

AIR RIDE SUSPENSION - MODULES

AIR RIDE SUSPENSION - MODULE INSPECTION

Condition	Code	Procedure
Attaching hardware loose	A	Require repair or replacement of loose part.
Attaching hardware missing	C	Require replacement of missing part.
Attaching hardware threads damaged	A	Require repair or replacement of part with damaged threads.
Attaching hardware threads stripped (threads missing)	A	Require replacement of part with stripped threads.
Housing cracked	2	Suggest repair or replacement.
Inoperative	A	Require replacement.
Missing	C	Require replacement.

AIR RIDE SUSPENSION - RELAYS (COMPRESSOR)

AIR RIDE SUSPENSION - RELAY (COMPRESSOR) INSPECTION

Condition	Code	Procedure
Housing cracked	2	(1) Suggest replacement.
Intermittent	A	Require replacement.
Missing	C	Require replacement.
Output signal incorrect	A	Require replacement.

(1) - If moisture enters the relay, it can reduce life expectancy or impair function.

AIR RIDE SUSPENSION - SWITCHES (ON/OFF)

AIR RIDE SUSPENSION - SWITCH (ON/OFF) INSPECTION

Condition	Code	Procedure
Broken	A	Require replacement.
Missing	C	Require replacement.
Output signal incorrect	A	Require replacement.

AIR RIDE SUSPENSION - TORSION SPRINGS (COUNTER BALANCING)

AIR RIDE SUSPENSION - TORSION SPRING (COUNTER BALANCING) INSPECTION

Condition	Code	Procedure
Attaching hardware bent	B	Require repair or replacement of bent part.
Attaching hardware broken	A	Require replacement of broken part.
Attaching hardware incorrect	A	Require replacement of incorrect part.
Attaching hardware loose	A	Require repair or replacement of loose part.
Attaching hardware missing	C	Require replacement of missing part.
Attaching hardware threads damaged	A	Require repair or replacement of part with damaged threads.
Attaching hardware threads stripped (threads missing)	A	Require replacement of part with stripped threads.
Broken	A	Require replacement.
Missing	C	Require replacement.

AIR RIDE SUSPENSION - TUBING

AIR RIDE SUSPENSION - TUBING INSPECTION

Condition	Code	Procedure
Attaching hardware incorrect	A	Require replacement of incorrect part.
Attaching hardware loose	A	Require repair or replacement of loose part.
Attaching hardware missing	C	Require replacement of missing part.
Blocked	A	Require repair or replacement.
Fitting incorrect	B	Require replacement.
Leaking	A	Require repair or replacement.
Line type incorrect	B	Require replacement.
Missing	C	Require replacement.
Restricted	A	Require repair or replacement.
Routed incorrectly	B	Require routing correction.

AIR RIDE SUSPENSION - WARNING LAMPS

AIR RIDE SUSPENSION - WARNING LAMP INSPECTION

Condition	Code	Procedure
Bulb burned out	A	Require replacement.
Warning light does not come on during bulb check	..	Further inspection required to determine cause.
Warning light flashes	..	Further inspection required to determine cause.
Warning light is intermittent	..	Further inspection required to determine cause.
Warning light stays on after initial bulb check	..	Further inspection required to determine cause.

AIR RIDE SUSPENSION - WIRING HARNESSES

AIR RIDE SUSPENSION - WIRING HARNESS INSPECTION

Condition	Code	Procedure
Connector bent	A	Require repair or replacement.
Connector broken	A	Require repair or replacement.
Connector loose	A	Require repair or replacement.
Damaged (cut, burned, or chafed)	A	Require repair or replacement.
Excessive resistance	B	Require repair or replacement.
Fuse blown	A	Require replacement.
Fusible link blown	A	Require replacement.
Open	A	Require repair or replacement.
Poor ground	A	Require repair or replacement.
Routed incorrectly	B	Require rerouting according to vehicle manufacturer's specifications.
Shorted	A	Require repair or replacement.
Terminal bent	A	Require repair or replacement.
Terminal broken	A	Require repair or replacement.
Terminal corroded	A	Require repair or replacement.
Terminal loose	A	Require repair or replacement.

BALL JOINTS

Before requiring or suggesting ball joint replacement, the approved OEM procedure must be used to measure ball joint wear. The measurement(s) obtained, along with the vehicle manufacturer's specifications, must be noted on the inspection report. Some states require that these measurements also appear on the invoice.

NOTE: The term "perceptible movement," defined as any visible movement in any direction, has been the industry standard for determining the need for replacement of follower ball joints. Some vehicle manufacturers are now publishing specifications for follower ball joints that were

previously diagnosed by the "perceptible movement" standard. Before requiring or suggesting any parts be replaced based on "perceptible movement," consult your repair manual to determine if OEM specifications exist.

You are not required to replace ball joints in axle sets. However, when replacing a ball joint due to wear exceeding manufacturer's specification, you may suggest replacement of the other ball joint if its measurement shows it is close to the end of its useful life, for preventive maintenance.

BALL JOINT INSPECTION

Condition	Code	Procedure
Attaching hardware bent	B	Require repair or replacement of bent part if available; otherwise, replace ball joint.
Attaching hardware broken	A	Require replacement of broken part if available; otherwise, replace ball joint.
Attaching hardware corroded, affecting structural integrity	A	Require replacement of corroded part if available; otherwise, replace ball joint.
Attaching hardware incorrect	A	Require replacement of incorrect part if available; otherwise, replace ball joint.
Attaching hardware loose	A	Require repair or replacement of loose part if available; otherwise, replace ball joint.
Attaching hardware missing	C	Require replacement of missing part if available; otherwise, replace ball joint.
Attaching hardware threads damaged	A	Require repair or replacement of part with damaged threads if available; otherwise, replace ball joint.
Attaching hardware threads stripped (threads missing)	A	Require replacement of part with stripped threads if available; otherwise, replace ball joint.
Binding	A	(1) Further inspection required.
Grease boot cracked	2	(2) Suggest replacement.
Grease boot missing	2	(3) Suggest replacement.
Grease boot torn	2	(4) Suggest replacement.
Grease fitting broken	A	Require replacement of grease fitting.
Grease fitting missing	C	Require replacement of grease fitting.
Grease fitting won't seal	A	Require replacement of grease fitting.
Greaseable ball joint will		

not take grease	2	(5) Suggest replacement of grease fitting.
Nut on ball joint loose	A	(6) Require repair or replacement.
Pre-load adjustment incorrect	B	Require repair or replacement.
Seized	A	Require replacement.
Stud bent	B	(7) Require replacement.
Stud broken	A	(7) Require replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	(7) Require replacement.
Wear exceeds manufacturer’s specifications	B	Require replacement.

(1) - If greaseable, grease ball joint. If problem persists or joint is non-greaseable, require replacement.
(2) - Cracked grease boot will allow contaminants to enter the ball joint and will accelerate wear.
(3) - Lack of grease boot will allow contaminants to enter the ball joint and will accelerate wear.
(4) - Torn grease boot will allow contaminants to enter the ball joint and will accelerate wear.
(5) - If the greaseable ball joint still will not take grease after replacing the grease fitting, suggest replacement of ball joint.
(6) - Check for bent stud or damaged taper hole.
(7) - Check for damaged taper hole.

BUSHINGS

BUSHING INSPECTION

Condition	Code	Procedure
Attaching hardware bent	B	Require repair or replacement of bent part if available; otherwise, replace bushing.
Attaching hardware broken	A	Require replacement of broken part if available; otherwise, replace bushing.
Attaching hardware corroded, affecting structural integrity	A	Require replacement of corroded part if available; otherwise, replace bushing.
Attaching hardware incorrect	A	Require replacement of incorrect part if available; otherwise, replace bushing.
Attaching hardware loose	A	Require repair or replacement of loose part if available; otherwise, replace bushing.
Attaching hardware missing	C	Require replacement of missing part if available; otherwise, replace bushing.
Attaching hardware threads damaged	A	Require repair or replacement

		of part with damaged threads if available; otherwise, replace bushing.
Attaching hardware threads stripped (threads missing)	A	Require replacement of part with stripped threads if available; otherwise, replace bushing.
Binding	A	Require repair or replacement.
Deteriorated, affecting performance	A	Require repair or replacement.
Distorted, affecting performance	A	Require repair or replacement.
Leaking (fluid-filled type)	A	Require replacement.
Missing	C	Require replacement.
Noisy	2	(1) Further inspection required.
Rubber separating from internal metal sleeve on bonded bushing	A	Require replacement.
Seized	A	Require replacement.
Shifted (out of position)	B	Require repair or replacement.
Split	A	Require replacement.
Surface cracking (weather-checked)	..	No service suggested or required.

(1) - If noise isolated to bushing, suggest repair or replacement.

CAUTION: Use only approved lubricant on rubber bushings. Petroleum-based lubricants may damage rubber bushings.

CENTER LINKS

CENTER LINK INSPECTION

Condition	Code	Procedure
Attaching hardware incorrect	A	Require replacement of incorrect part, if available; otherwise, replace center link.
Attaching hardware loose	A	Require repair or replacement of loose part, if available; otherwise, replace center link.
Attaching hardware missing	C	Require replacement of missing part, if available; otherwise, replace center link.
Attaching hardware threads damaged	A	Require repair or replacement of part with damaged threads, if available; otherwise, replace center link.
Attaching hardware threads stripped (threads missing)	A	Require replacement of part with stripped threads, if

		available; otherwise, replace center link.
Bent	B	Require replacement.
Binding	A	(1) Further inspection required.
Grease boot cracked	2	(2) Suggest replacement.
Grease boot missing	2	(3) Suggest replacement.
Grease boot torn	2	(4) Suggest replacement.
Grease fitting broken	A	Require replacement of grease fitting.
Grease fitting missing	C	Require replacement of grease fitting.
Grease fitting won't seal	A	Require replacement of grease fitting.
Grease seal missing	2	(3) Suggest replacement.
Grease seal torn	2	(4) Suggest replacement.
Looseness (perceptible horizontal movement)	1	(5) Suggest replacement.
Looseness that is excessive	B	(5)(6) Require replacement.
Seized	A	Require replacement.
Stud bent	B	(7) Require replacement.
Stud broken	A	(7) Require replacement.
Stud loose in taper hole	A	(7) Require repair or replacement.
Taper hole elongated	A	(8) Require replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	(7) Require replacement.
Wear exceeds manufacturer's specifications	B	Require replacement.

(1) - If greaseable, grease joint. If problem persists or joint is non-greaseable, require replacement.
(2) - Cracked grease boot will allow contaminants to enter the joint and will accelerate wear.
(3) - Lack of grease boot will allow contaminants to enter the joint and will accelerate wear.
(4) - Torn grease boot will allow contaminants to enter the joint and will accelerate wear.
(5) - If manufacturer's procedures for inspection exist, use those procedures; otherwise, use an approved inspection method such as the dry park check.
CAUTION: DO NOT use pliers or pry bar to check ball and socket movement. Use only moderate hand pressure.
(6) - Excessive looseness is defined as being significant enough to affect vehicle handling or structural integrity.
(7) - Check for damaged taper hole.
(8) - Check for damaged stud.

CONTROL ARM SHAFTS

CONTROL ARM SHAFT INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require replacement of broken

		part, if available; otherwise, replace shaft.
Attaching hardware loose	A	... Require repair or replacement of loose part, if available; otherwise, replace shaft.
Attaching hardware missing	C	.. Require replacement of missing part, if available; otherwise, replace shaft.
Attaching hardware threads damaged	A	... Require repair or replacement of part with damaged threads, if available; otherwise, replace shaft.
Attaching hardware threads stripped (threads missing)	A	..... Require replacement of part with stripped threads, if available; otherwise, replace shaft.
Bent	B	.... Require replacement.
Shaft bushing surface undersized (worn)	B	.... Require replacement.
Threads damaged	A	.. Require repair or replacement.
Threads stripped (threads missing)	A	.... Require replacement.

CONTROL ARMS

CONTROL ARM INSPECTION

Condition	Code	Procedure
Attaching hardware bent	B	... Require repair or replacement of bent part, if available; otherwise, replace control arm.
Attaching hardware broken	A	... Require replacement of broken part, if available; otherwise, replace control arm.
Attaching hardware corroded, affecting structural integrity ...	A	. Require replacement of corroded part, if available; otherwise, replace control arm.
Attaching hardware incorrect	A	.... Require replacement of incorrect part, if available; otherwise, replace control arm.
Attaching hardware loose	A	... Require repair or replacement of loose part, if available; otherwise, replace control arm.
Attaching hardware missing	C	.. Require replacement of missing part, if available; otherwise, replace control arm.
Attaching hardware threads damaged	A	... Require repair or replacement of part with damaged threads,

		if available; otherwise, replace control arm.
Attaching hardware threads stripped (threads missing)	A	Require replacement of part with stripped threads, if available; otherwise, replace control arm.
Bent	B	Require replacement.
Bushing hole oversized	B	Require replacement.
Ball joint hole oversized (loose interference or press fit)	B	(1) Further inspection required.
Corroded, affecting structural integrity	A	Require replacement.
Holes distorted	A	Require replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.

(1) - If oversized ball joint is available, require replacement of ball joint. If oversized ball joint is not available, require replacement of control arm.

DRAG LINKS

DRAG LINK INSPECTION

Condition	Code	Procedure
Attaching hardware incorrect	A	Require replacement of incorrect part, if available; otherwise, replace drag link.
Attaching hardware loose	A	Require repair or replacement of loose part, if available; otherwise, replace drag link.
Attaching hardware missing	C	Require replacement of missing part, if available; otherwise, replace drag link.
Attaching hardware threads damaged	A	Require repair or replacement of part with damaged threads, if available; otherwise, replace drag link.
Attaching hardware threads stripped (threads missing)	A	Require replacement of part with stripped threads, if available; otherwise, replace drag link.
Bent	B	Require replacement.
Binding	A	(1) Further inspection required.
Grease boot cracked	2	(2) Suggest replacement.
Grease boot missing	2	(3) Suggest replacement.
Grease boot torn	2	(4) Suggest replacement.
Grease fitting broken	A	Require replacement of grease fitting.

Grease fitting missing	C	Require replacement of grease fitting.
Grease fitting won't seal	A	Require replacement of grease fitting.
Grease seal missing	2	(5) Suggest replacement.
Grease seal torn	2	(4) Suggest replacement.
Looseness (perceptible horizontal movement)	1	(6) Suggest replacement.
Looseness that is excessive	B	(6)(7) Require replacement.
Seized	A	Require replacement.
Stud bent	B	(8) Require replacement.
Stud broken	A	(8) Require replacement.
Stud loose in taper hole	A	(8) Require repair or replacement.
Taper hole elongated	A	(9) Require replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	(8) Require replacement.
Wear exceeds manufacturer's specifications	B	Require replacement.

(1) - If greaseable, grease joint. If problem persists or joint is non-greaseable, require replacement.
(2) - Cracked grease boot will allow contaminants to enter the joint and will accelerate wear.
(3) - Lack of grease boot will allow contaminants to enter the joint and will accelerate wear.
(4) - Torn grease boot will allow contaminants to enter the joint and will accelerate wear.
(5) - Missing grease seal will allow contaminants to enter the joint and will accelerate wear.
(6) - If manufacturer's procedures for inspection exist, use those procedures; otherwise, use an approved inspection method such as the dry park check.
CAUTION: DO NOT use pliers or pry bar to check ball and socket movement. Use only moderate hand pressure.
(7) - Excessive looseness is defined as being significant enough to affect vehicle handling or structural integrity.
(8) - Check for damaged taper hole.
(9) - Check for damaged stud.

ELECTRONIC RIDE CONTROL SHOCKS AND STRUTS

NOTE: This section covers the electronic damping control portion of the electronic shock or strut. For dampening portion of shock or strut conditions and procedures, refer to the SHOCK ABSORBERS, STRUT CARTRIDGES AND STRUT ASSEMBLIES section.

ELECTRONIC RIDE CONTROL SHOCK AND STRUT INSPECTION

Condition	Code	Procedure
Connector bent	A	Require repair or replacement.
Connector broken	A	Require repair or replacement.
Connector loose	A	Require repair or replacement.
Electronic valve control		

inoperative	2	(1) Suggest replacement.
Terminal bent	A	Require repair or replacement.
Terminal broken	A	Require repair or replacement.
Terminal corroded	A	Require repair or replacement.
Terminal loose	A	Require repair or replacement.

(1) - It is acceptable to replace with a non-electronically controlled unit, where available.

IDLER ARMS

IDLER ARM INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require replacement of broken part, if available; otherwise, replace idler arm.
Attaching hardware incorrect	A	Require replacement of incorrect part, if available; otherwise, replace idler arm.
Attaching hardware loose	A	Require repair or replacement of loose part, if available; otherwise, replace idler arm.
Attaching hardware missing	C	Require replacement of missing part, if available; otherwise, replace idler arm.
Attaching hardware threads damaged	A	Require repair or replacement of part with damaged threads, if available; otherwise, replace idler arm.
Attaching hardware threads stripped (threads missing)	A	Require replacement of part with stripped threads, if available; otherwise, replace idler arm.
Binding	A	(1) Further inspection required.
Grease boot cracked	2	(2) Suggest replacement.
Grease boot missing	2	(3) Suggest replacement.
Grease boot torn	2	(4) Suggest replacement.
Grease fitting broken	A	Require replacement of grease fitting.
Grease fitting missing	C	Require replacement of grease fitting.
Grease fitting won't seal	A	Require replacement of grease fitting.
Grease seal missing	2	(5) Suggest replacement.
Grease seal torn	2	(4) Suggest replacement.
Greaseable joint will not take grease	2	(1) Suggest replacement of grease fitting.
Looseness at frame bracket end	B	(6)(7) Require repair or replacement.

Looseness at link end (perceptible horizontal movement)	1	(8) Suggest replacement.
Looseness at link end that is excessive	B	(8)(9) Require replacement.
Mounted out of position (center link not parallel)	B	Require repositioning.
Nut on stud loose	A	(10) Require repair or replacement.
Seized	A	Require replacement.
Stud bent	B	(11) Require replacement.
Stud broken	A	(11) Require replacement.
Taper hole elongated	A	(12) Require replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	(11) Require replacement.
Wear exceeds manufacturer's specifications	B	Require replacement.

(1) - If greaseable, grease joint. If problem persists or joint is non-greaseable, require replacement.
(2) - Cracked grease boot will allow contaminants to enter joint and will accelerate wear.
(3) - Lack of grease boot will allow contaminants to enter joint and will accelerate wear.
(4) - Torn grease boot will allow contaminants to enter joint and will accelerate wear.
(5) - Missing grease seal will allow contaminants to enter joint and will accelerate wear.
(6) - If manufacturer's procedures and specifications exist, use those procedures and specifications; otherwise, use an approved inspection method such as the dry park check.
(7) - Looseness is defined as movement that creates excessive toe change.
(8) - If manufacturer's procedures for inspection exist, use those procedures; otherwise, use an approved inspection method such as the dry park check.
CAUTION: DO NOT use pliers or pry bar to check ball and socket movement. Use only moderate hand pressure.
(9) - Excessive looseness is defined as significant enough to affect vehicle handling or structural integrity.
(10) - Check for bent stud or damaged taper hole.
(11) - Check for damaged taper hole.
(12) - Check for damaged stud.

KING PINS

You are not required to replace king pins in axle sets. However, when replacing a king pin due to wear exceeding manufacturer's specifications, you may suggest replacement of the other king pin on the axle if its measurement shows it is close to the end of its useful life.

KING PIN INSPECTION

Condition	Code	Procedure
Bearing balls pitted	A	Require replacement.
Bearing balls worn	A	Require replacement.
Bearing races pitted	A	Require replacement.

Bearing races worn	A	.... Require replacement.
Bearing rollers pitted ..	A	.... Require replacement.
Bearing rollers worn	A	.... Require replacement.
Bearing seal bent	2	. Suggest replacement of seal or bearing.
Bearing seal missing	2	. Suggest replacement of seal or bearing.
Bearing seal torn	2	. Suggest replacement of seal or bearing.
Binding	A	.. Require repair or replacement of affected parts.
End caps missing	C	. Require replacement of missing part, if available; otherwise, replace king pin.
End play exceeds specifications	B	.... Require repair.
Grease fitting broken ...	A	.. Require replacement of grease fitting.
Grease fitting missing ..	C	.. Require replacement of grease fitting.
Grease fitting won't seal	A	.. Require replacement of grease fitting.
Locating pins missing ...	C	. Require replacement of missing part, if available; otherwise, replace king pin.
Looseness exceeds manufacturer's specifications	B	.... Require replacement of worn parts.
Seized	A	.... Require replacement.
Threads damaged	A	. Require repair or replacement.
Threads stripped (threads missing)	A	.... Require replacement.
Will not take grease	2	..... (1) Suggest replacement of grease fitting.

(1) - If king pin will not take grease after replacement of grease fitting, suggest replacement of king pin.

PITMAN ARMS

PITMAN ARM INSPECTION

Condition	Code	Procedure
Attaching hardware incorrect	A	.... Require replacement of incorrect part, if available; otherwise, replace pitman arm.
Attaching hardware loose	A	... Require repair or replacement of loose part, if available; otherwise, replace pitman arm.
Attaching hardware missing	C	.. Require replacement of missing part, if available; otherwise, replace pitman arm.
Attaching hardware threads damaged	A	... Require repair or replacement of part with damaged threads, if available; otherwise,

		replace pitman arm.
Attaching hardware threads stripped (threads missing)	A	Require replacement of part with stripped threads, if available; otherwise, replace pitman arm.
Bent	B	Require replacement.
Binding	A	(1) Further inspection required.
Grease boot cracked	2	(2) Suggest replacement.
Grease boot missing	2	(3) Suggest replacement.
Grease boot torn	2	(4) Suggest replacement.
Grease fitting broken	A	Require replacement grease fitting.
Grease fitting missing	C	Require replacement of grease fitting.
Grease fitting won't seal	A	Require replacement of grease fitting.
Grease seal missing	2	(3) Suggest replacement of seal.
Grease seal torn	2	(4) Suggest replacement of seal.
Looseness (perceptible horizontal movement)	1	(5) Suggest replacement.
Looseness that is excessive	B	(5)(6) Require replacement.
Nut on stud loose	A	(7) Require repair or replacement.
Seized	A	Require replacement.
Splines damaged	A	Require repair or replacement.
Splines stripped (splines missing)	A	Require replacement.
Stud bent	B	(8) Require replacement.
Stud broken	A	(8) Require replacement.
Stud loose in taper hole	A	(8) Require repair or replacement.
Taper hole elongated	A	(9) Require replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	(8) Require replacement.

(1) - If greaseable, grease joint. If problem persists or joint is non-greaseable, require replacement.
(2) - Cracked grease boot will allow contaminants to enter joint and will accelerate wear.
(3) - Lack of grease boot will allow contaminants to enter joint and will accelerate wear.
(4) - Torn grease boot will allow contaminants to enter joint and will accelerate wear.
(5) - If manufacturer's procedures for inspection exist, use those procedures; otherwise, use an approved inspection method such as the dry park check.
CAUTION: DO NOT use pliers or pry bar to check ball and socket movement. Use only moderate hand pressure.
(6) - Excessive looseness is defined as being significant enough to affect vehicle handling or structural integrity.
(7) - Check for bent stud of damaged taper hole.
(8) - Check for damaged taper hole.
(9) - Check for damaged stud.

POWER STEERING HOSES

POWER STEERING HOSE INSPECTION

Condition	Code	Procedure
Blistered	B	Require replacement.
Blocked	A	Require repair or replacement.
Fitting threads damaged	A	Require repair or replacement.
Fitting threads stripped (threads missing)	A	Require replacement.
Inner fabric (webbing) cut	A	Require replacement.
Leaking	A	Require repair or replacement.
Missing	C	Require replacement.
Outer covering is cracked to the extent that the inner fabric of hose is visible	B	Require replacement.
Restricted	A	Require repair or replacement.

POWER STEERING (HYDRAULIC) PUMPS

If diagnosis has determined that complete disassembly is necessary to determine the extent of the system failure, the suggestion may be made to rebuild or replace the power steering pump. Repair or replacement of the following components may be required if performed as part of a power steering pump overhaul or rebuild service to meet a minimum rebuild standard.

POWER STEERING (HYDRAULIC) PUMP INSPECTION

Condition	Code	Procedure
Attaching hardware bent	B	Require repair or replacement of bent part.
Attaching hardware broken	A	Require replacement of broken part.
Attaching hardware loose	A	Require repair or replacement of loose part.
Attaching hardware missing	C	Require replacement of missing part.
Attaching hardware threads damaged	A	Require repair or replacement of part with damaged threads.
Attaching hardware threads stripped (threads missing)	A	Require replacement of part with stripped threads.
Belt alignment incorrect	B	(1) Further inspection required.
Belt cracked	1	Suggest replacement.
Belt frayed	1	Suggest replacement.
Belt missing	C	Require replacement.
Belt noisy	2	(2) Further inspection required.
Belt plies separated	A	Require replacement.

Belt tension out of specification	B	Require adjustment or replacement.
Belt worn beyond adjustment range	B	Require replacement.
Belt worn so it contacts bottom of pulley	A	Require replacement.
Binding	A	Require repair or replacement.
Fluid at or beyond service interval	3	Suggest fluid change.
Fluid contaminated	B	(3) Require flushing and refilling of the system.
Fluid level incorrect	B	Require adjustment of fluid level.
Inadequate assist	A	(4) Further inspection required.
Leaking	A	Require repair or replacement.
Noise	2	(5) Further inspection required.
Pulley bent	A	Require repair or replacement of pulley.
Pulley missing	C	Require replacement of pulley.
Remote reservoir leaking	A	Require replacement of reservoir,
Reservoir cap broken	A	Require replacement of cap.
Reservoir cap missing	C	Require replacement of cap.
Seized	A	Require replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.

(1) - Determine cause of incorrect alignment and require repair.
(2) - Determine cause of noise and suggest repair.
(3) - Determine and correct source of contamination. OEM specifications must be followed for fluid type.
(4) - If pump is source of inadequate assist, require repair or replacement.
(5) - If noise is isolated to pump, suggest repair or replacement.

RADIUS ARMS

RADIUS ARM INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require replacement of broken part.
Attaching hardware incorrect	A	Require replacement of incorrect part.
Attaching hardware loose	A	Require repair or replacement of loose part.
Attaching hardware missing	C	Require replacement of missing part.
Attaching hardware threads damaged	A	Require repair or replacement of part with damaged threads.

Attaching hardware threads stripped (threads missing)	A	Require replacement of part with stripped threads.
Bent	B	Require replacement.
Corroded, affecting structural integrity	A	Require replacement.
Holes distorted	A	Require replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.

RELAY RODS

RELAY ROD INSPECTION

Condition	Code	Procedure
Attaching hardware incorrect	A	Require replacement of incorrect part, if available; otherwise, replace relay rod.
Attaching hardware loose	A	Require repair or replacement of loose part, if available; otherwise, replace relay rod.
Attaching hardware missing	C	Require replacement of missing part, if available; otherwise, replace relay rod.
Attaching hardware threads damaged	A	Require repair or replacement of part with damaged threads, if available; otherwise, replace relay rod.
Attaching hardware threads stripped (threads missing)	A	Require replacement of part with stripped threads, if available; otherwise, replace relay rod.
Bent	B	Require replacement.
Binding	A	(1) Further inspection required.
Grease boot cracked	2	(2) Suggest replacement.
Grease boot missing	2	(3) Suggest replacement.
Grease boot torn	2	(4) Suggest replacement.
Grease fitting broken	A	Require replacement grease fitting.
Grease fitting missing	C	Require replacement of grease fitting.
Grease fitting won’t seal	A	Require replacement of grease fitting.
Grease seal missing	2	(3) Suggest replacement.
Grease seal torn	2	(4) Suggest replacement.
Looseness (perceptible horizontal movement)	1	(5) Suggest replacement.
Looseness that is excessive	B	(5)(6) Require replacement.
Seized	A	Require replacement.
Stud bent	B	(7) Require replacement.

Stud loose in taper hole	A	(7) Require repair or replacement.
Taper hole elongated	A	(8) Require replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	(7) Require replacement.
Wear exceeds manufacturer's specifications	B	Require replacement.

(1) - If greaseable, grease joint. If problem persists or joint is non-greaseable, require replacement.
(2) - Cracked grease boot will allow contaminants to enter the joint and will accelerate wear.
(3) - Lack of grease boot will allow contaminants to enter the joint and will accelerate wear.
(4) - Torn grease boot will allow contaminants to enter the joint and will accelerate wear.
(5) - If manufacturer's procedures for inspection exist, use those procedures; otherwise, use an approved inspection method such as the dry park check.
CAUTION: DO NOT use pliers or pry bar to check ball and socket movement. Use only moderate hand pressure.
(6) - Excessive looseness is defined as being significant enough to affect vehicle handling or structural integrity.
(7) - Check for damaged taper hole.
(8) - Check for damaged stud.

SHOCK ABSORBERS, STRUT CARTRIDGES AND STRUT ASSEMBLIES

You are not required to replace shocks or struts in axle sets. However, when replacing a shock or strut due to the conditions that follow, you may suggest replacement of the other shock or strut on the same axle for improved performance and preventive maintenance.

* Part is close to the end of its useful life
* To extend tire life
* To balance ride and handling
* To improve stopping distance

When replacing steering and/or suspension components which may affect an alignment angle, you are required to check and adjust alignment as needed. Refer to the OEM specifications.

Under no circumstances should a technician bend struts or strut housings.

A vehicle's load-carrying and handling abilities are limited by its suspension, tires, brakes, and driveline. Installing coil over shocks or any other load assist device does not increase the vehicle's load capacity. See the vehicle owner's manual for more details.

NOTE: If vehicle is equipped with original equipment coil over shocks, apply the conditions for coil springs from the SPRINGS - COIL, LEAF AND TORSION BAR section of the STEERING AND SUSPENSION guidelines. If the vehicle is equipped with add-on coil over shocks, you may suggest replacing the shocks with standard shocks for any spring-related condition.

SHOCK ABSORBER, STRUT CARTRIDGE AND STRUT ASSEMBLY INSPECTION

Condition	Code	Procedure
Attaching hardware bent	B	Require repair or replacement of bent part, if available; otherwise, replace shock or strut.
Attaching hardware broken	A	Require replacement of broken part, if available; otherwise, replace shock or strut.
Attaching hardware corroded, affecting structural integrity	A	Require replacement of corroded part, if available; otherwise, replace shock or strut.
Attaching hardware incorrect	A	Require replacement of incorrect part, if available; otherwise, replace shock or strut.
Attaching hardware loose	A	Require repair or replacement of loose part, if available; otherwise, replace shock or strut.
Attaching hardware missing	C	Require replacement of missing part, if available; otherwise, replace shock or strut.
Attaching hardware threads damaged	A	Require repair or replacement of part with damaged threads, if available; otherwise, replace shock or strut.
Attaching hardware threads stripped (threads missing)	A	Require replacement of part with stripped threads, if available; otherwise, replace shock or strut.
Binding	A	Require replacement.
Body dented	A	(1) Further inspection required.
Body punctured	A	Require replacement.
Brake hose bracket bent	B	Require repair or replacement.
Brake hose bracket missing	C	Require replacement.
Brake hose bracket threads damaged	A	Require repair or replacement.
Brake hose bracket threads stripped (threads missing)	C	Require replacement.
Compression bumper missing	C	Require replacement of compression bumper.
Compression bumper split	1	Suggest replacement of compression bumper.
Damping (none)	A	Require replacement.
Dust boot (bellows) split	2	(2) Suggest replacement of boot.

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Dust boot (bellows)
 missing ................  2 .........  (2) Suggest replacement
                                                    of boot.
Dust boot (bellows)
 torn ...................  2 .........  (2) Suggest replacement
                                                    of boot.
Dust shield broken ......  2 ........  (2) Suggest replacement.
Dust shield missing .....  2 ........  (2) Suggest replacement.
Gland nut (strut housing
 cap) is not removable
 using appropriate tool .  A ..  (3) Require replacement of nut
                                              and/or housing.
Gland nut (strut housing
 cap) threads damaged ...  A ...  Require repair or replacement
                                                     of nut.
Gland nut (strut housing
 cap) threads stripped
 (threads missing) ......  A .....  Require replacement of nut.
Housing dented ..........  A ..........  (1) Further inspection
                                                   required.
Housing punctured .......  A ............  Require replacement.
Jounce bumper missing ...  C ...  Require replacement of jounce
                                                     bumper.
Jounce bumper split .....  1 ...  Suggest replacement of jounce
                                                     bumper.
Leaking oil, enough for
 fluid to be running down
 the body ...............  A ........  (4) Require replacement.
Noise ...................  2 ..........  (5) Further inspection
                                                   required.
Piston rod bent .........  A ............  Require replacement.
Piston rod broken .......  A ............  Require replacement.
Piston rod has surface
 defect .................  2 ............  Suggest replacement.
Piston rod threads
 damaged ................  A ..  Require repair or replacement.
Piston rod threads
 stripped (threads
 missing) ...............  A ............  Require replacement.
Seized ..................  A ............  Require replacement.
Shock missing ...........  C ............  Require replacement.
Strut housing bent ......  A ............  Require replacement.
Strut housing cap (gland
 nut) is not removable
 using appropriate tool .  A .........  (3) Require replacement
                                       of nut and/or housing.
Strut housing cap (gland
 nut) threads damaged ...  A ...  Require repair or replacement
                                                     of nut.
Strut housing cap (gland
 nut) threads stripped
 (threads missing) ......  A .....  Require replacement of nut.
Strut housing severely
 corroded, affecting
 structural integrity ...  A ............  Require replacement.
Strut housing threads
 damaged ................  A ..  Require repair or replacement.
Strut housing threads
 stripped (threads
 missing) ...............  A ............  Require replacement.
Tire cupping ............  A ..........  (6) Further inspection
                                                   required.
```

(1) - Require replacement of units where dents restrict shock or strut piston rod movement. If dents don't restrict movement, no service is suggested or required. Especially critical on mono-tube shocks.
(2) - This condition can lead to damage of the piston rod, which, in turn, causes premature piston rod seal wear.
(3) - Only required if replacing cartridge.
(4) - CAUTION: If the strut cartridge has been replaced previously, the oil on the strut housing may be filler oil. The technician must identify the source of the oil.
(5) - If noise is isolated to shock or strut, suggest replacement.
(6) - Although shocks or struts may have contributed to tire cupping, an inspection is needed of the entire suspension system. If the shock or strut is found to be contributing to the tire cupping, require replacement.

SPINDLES

SPINDLE INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require replacement of broken part.
Attaching hardware loose	A	Require repair or replacement of loose part.
Attaching hardware missing	C	Require replacement of missing part.
Attaching hardware threads damaged	A	Require repair or replacement of part with damaged threads.
Attaching hardware threads stripped (threads missing)	A	Require replacement of part with stripped threads.
Bent	B	Require replacement.
Broken	A	Require replacement.
Race seat area undersized	B	Require replacement.
Scored	A	Require repair or replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.

SPRINGS - COIL, LEAF AND TORSION BAR

When springs are replaced, it is suggested, but not required, that both springs on an axle be replaced to maintain equal height from side to side and to provide a balanced ride and proper handling.

When variable rate springs are installed in place of conventional coil springs, they must be installed in axle sets to ensure proper handling, uniform ride, and proper chassis height.

Erroneous height measurements may result from: improper tire inflation, non-standard tire or wheel size, and heavy load in vehicle or trunk.

SPRING (COIL, LEAF AND TORSION BAR) INSPECTION

Condition	Code	Procedure
Attaching hardware bent	B	Require repair or replacement of bent part.
Attaching hardware broken	A	Require replacement of broken part.
Attaching hardware corroded, affecting structural integrity	A	Require replacement of corroded part.
Attaching hardware incorrect	A	Require replacement of incorrect part.
Attaching hardware loose	A	Require repair or replacement of loose part.
Attaching hardware missing	C	Require replacement of missing part.
Attaching hardware threads damaged	A	Require repair or replacement of part with damaged threads.
Attaching hardware threads stripped (threads missing)	A	Require replacement of part with stripped threads.
Broken (all springs except secondary leave(s) on multi-leaf springs)	A	Require replacement.
Coil clash	..	(1) Require ride height check.
Coil spring insulator deteriorated	2	Suggest replacement of insulator.
Coil spring insulator missing	2	Suggest replacement of insulator.
Coil spring insulator split	2	Suggest replacement of insulator.
Coil spring plastic coating deteriorated – rust present	A	(2) Refer to manufacturer's service requirements.
Composite spring damaged	..	(3) Further inspection required.
Cracked (all springs except composite leaf and secondary leave(s) on multi-leaf springs)	A	Require replacement.
Installed incorrectly	B	Require repair.
Leaf spring insulators missing	2	Suggest replacement of insulators.
Secondary leaf on multi-leaf spring broken	1	Suggest repair or replacement
Secondary leaf on multi-leaf spring cracked	1	Suggest repair or replacement
Torsion bar		

adjuster bent	A	(4) Require repair or replacement of adjuster.
Torsion bar adjuster seized	A	(4) Require repair or replacement of adjuster.
Torsion bar adjuster threads damaged	A	(4) Require repair or replacement of part with damaged threads.
Torsion bar adjuster threads stripped (threads missing)	A	Require replacement of part with stripped threads.
Vehicle suspension height not within OEM specifications	B	Require adjustment or replacement.

(1) - If vehicle is within manufacturer's height specifications, no service is suggested or required.
(2) - Some manufacturers require replacement under these conditions.
(3) - Check vehicle ride height. If ride height is OK, no service is suggested or required.
(4) - Only required if ride height needs to be adjusted.

STEEL POWER STEERING LINES

CAUTION: When replacing steel power steering lines, be sure to use a replacement product that meets or exceeds OEM design specifications.

STEEL POWER STEERING LINE INSPECTION

Condition	Code	Procedure
Attaching hardware bent	B	Require repair or replacement of bent part.
Attaching hardware broken	A	Require replacement of broken part.
Attaching hardware loose	A	Require repair or replacement of loose part.
Attaching hardware missing	C	Require replacement of missing part.
Attaching hardware threads damaged	A	Require repair or replacement of part with damaged threads.
Attaching hardware threads stripped (threads missing)	A	Require replacement of part with stripped threads.
Blocked	A	Require repair or replacement.
Fitting incorrect (such as compression fitting)	B	Require replacement.
Flare type incorrect	B	Required replacement.
Leaking	A	Require tightening or replacement.
Line type incorrect	B	Require replacement.

Restricted	A	Require replacement.
Routed incorrectly	B	Require routing correction.
Rust-pitted	1	Suggest replacement.
Rust pitted, affecting structural integrity ..	A	Require replacement.

STEERING ARMS

STEERING ARM INSPECTION

Condition	Code	Procedure
Attaching hardware bent	B ...	Require repair or replacement of bent part.
Attaching hardware broken	A ...	Require replacement of broken part.
Attaching hardware incorrect	A	Require replacement of incorrect part.
Attaching hardware loose	A ...	Require repair or replacement of loose part.
Attaching hardware missing	C ..	Require replacement of missing part.
Attaching hardware threads damaged	A ...	Require repair or replacement of part with damaged threads.
Attaching hardware threads stripped (threads missing)	A	Require replacement of part with stripped threads.
Bent	B	Require replacement.
Broken	A	Require replacement.
Taper hole elongated	A	(1) Require replacement.
Threads damaged	A ..	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.

(1) - Check for damaged stud.

STEERING DAMPERS

The following procedures are only required if the vehicle was originally equipped from the factory with a steering damper. If the steering damper is an add-on unit, then the unit may be removed instead of repairing or replacing.

STEERING DAMPER INSPECTION

Condition	Code	Procedure
Attaching hardware bent .	B ...	Require repair or replacement of bent part, if available; otherwise, replace steering damper.
Attaching hardware broken	A ...	Require replacement of broken part, if available; otherwise,

		replace steering damper.
Attaching hardware corroded, affecting structural integrity	A	Require replacement of corroded part, if available; otherwise, replace steering damper.
Attaching hardware incorrect	A	Require replacement of incorrect part, if available; otherwise, replace steering damper.
Attaching hardware loose	A	Require repair or replacement of loose part, if available; otherwise, replace steering damper.
Attaching hardware missing	C	Require replacement of missing part, if available; otherwise, replace steering damper.
Attaching hardware threads damaged	A	Require repair or replacement of part with damaged threads, if available; otherwise, replace steering damper.
Attaching hardware threads stripped (threads missing)	A	Require replacement of part with stripped threads, if available; otherwise, replace steering damper.
Binding	A	Require replacement.
Damper body dented	A	(1) Further inspection required.
Damper body punctured	A	Require replacement.
Damping (none)	A	Require replacement.
Dust boot (bellows) missing	2	(2) Suggest replacement of boot.
Dust boot (bellows) split	2	(2) Suggest replacement of boot.
Dust shield broken	2	(2) Suggest replacement.
Dust shield missing	2	(2) Suggest replacement.
Leaking oil, enough for fluid to be running down the body	A	Require replacement.
Loose	A	Require repair or replacement.
Missing	C	Require replacement.
Noise	2	(3) Further inspection required.
Piston rod bent	A	Require replacement.
Piston rod broken	A	Require replacement.
Piston rod has surface defect	2	Suggest replacement.
Piston rod threads stripped (threads missing)	A	Require replacement.
Piston rod threads damaged	A	Require repair or replacement.
Seized	A	Require replacement.

(1) - Require replacement of units where dents restrict damper

piston rod movement. If dents don't restrict movement, no service is suggested or required. Especially critical on mono-tube dampers.
(2) - This condition can lead to damage of the piston rod, which, in turn, causes premature piston rod seal wear.
(3) - If noise is isolated to damper, suggest replacement.

STEERING GEARS (EXCEPT RACK AND PINION)

If diagnosis has determined that complete disassembly is necessary to determine the extent of the system failure, the suggestion may be made to rebuild or replace the power steering pump. Repair or replacement of the following components may be required, if performed as part of a power steering pump overhaul or rebuild service to meet a minimum rebuild standard.

STEERING GEAR (EXCEPT RACK AND PINION) INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require replacement of broken part.
Attaching hardware loose	A	Require repair or replacement of loose part.
Attaching hardware missing	C	Require replacement of missing part.
Attaching hardware threads damaged	A	Require repair or replacement of part with damaged threads.
Attaching hardware threads stripped (threads missing)	A	Require replacement of part with stripped threads.
Binding	A	Require repair or replacement
Flex coupler binding	A	Require repair or replacement of coupler.
Flex coupler loose	A	Require repair or replacement of coupler.
Flex coupler missing parts	A	Require repair or replacement of coupler.
Flex coupler soft/spongy	A	Require replacement of coupler.
Flex coupler torn	A	Require replacement of coupler.
Fluid contaminated	B	(1) Require flushing and refilling of the system.
Gasket leaking	A	Require repair or replacement of gasket.
Housing leaking	A	Require replacement.
Hydraulic fittings leaking	A	Require repair or replacement of fittings.
Inadequate power assist	A	(2) Further inspection required. See note below.
Lash exceeds manufacturer's specifications	B	Require repair or replacement.
Seal leaking	A	Require repair or replacement

		of seal and/or mating part.
Splines damaged	A	Require repair or replacement of splines.
Splines stripped	A	Require replacement of splines.
Steering coupler shield cracked	2	Suggest replacement.
Steering coupler shield missing	C	Require replacement.
Threads damaged	A	Require repair or replacement of part with damaged threads.
Threads stripped (threads missing)	A	Require replacement of part with stripped threads.
U-joint binding	A	Require repair or replacement of joint.
U-joint loose	A	Require repair or replacement of joint.
Unequal power assist	A	Require repair or replacement.

(1) - Determine and correct source of contamination. OEM specifications must be followed for fluid type.
(2) - If steering gear is source of inadequate assist, require repair or replacement.

STEERING GEARS - RACK AND PINION

If diagnosis has determined that complete disassembly is necessary to determine the extent of the system failure, the suggestion may be made to rebuild or replace the power steering pump. Repair or replacement of the following components may be required, if performed as part of a power steering pump overhaul or rebuild service to meet a minimum rebuild standard.

STEERING GEARS - RACK AND PINION INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require replacement of broken part.
Attaching hardware loose	A	Require repair or replacement of loose part.
Attaching hardware missing	C	Require replacement of missing part.
Attaching hardware threads damaged	A	Require repair or replacement of part with damaged threads.
Attaching hardware threads stripped (threads missing)	A	Require replacement of part with stripped threads.
Balance tube blocked	A	Require repair or replacement of balance tube.
Balance tube missing	C	Require replacement of balance tube.
Balance tube restricted	A	Require repair or replacement of balance tube.
Bellows boot clamp missing	C	Require replacement of clamp.
Bellows boot cracked		

(not through)	2	Suggest replacement of bellows boot.
Bellows boot missing	C	Require replacement of bellows boot.
Bellows boot not sealing	A	Require repair or replacement of bellows boot.
Bellows boot torn	A	Require replacement of bellows boot.
Bellows boot twisted (from toe adjustment)	B	Require repair.
Fitting leaking	A	Require repair or replacement.
Fitting missing	A	Require replacement of fitting.
Fitting threads damaged	A	Require repair or replacement of part with damaged threads.
Fitting threads stripped (threads missing)	A	Require replacement of part with stripped threads.
Flex coupler binding	A	Require repair or replacement of coupler.
Flex coupler loose	A	Require repair or replacement of coupler.
Flex coupler missing parts	A	Require repair or replacement of coupler.
Flex coupler soft/spongy	A	Require replacement of coupler.
Flex coupler torn	A	Require replacement of coupler.
Fluid contaminated	B	(1) Require flushing and refilling of the system.
Gasket leaking	A	Require repair or replacement.
Hard steering on cold start-up	1	(2) Suggest repair or replacement.
Housing cracked, affecting structural integrity	B	Require replacement.
Housing leaking	A	Require replacement.
Inadequate power assist	A	(3) Further inspection required.
Lash exceeds manufacturer's specifications	B	Require repair or replacement.
Seal leaking	A	Require repair or replacement.
Splines damaged	A	Require repair or replacement.
Splines stripped (splines missing)	A	Require replacement.
Steel line blocked	A	Require repair or replacement of line.
Steel line leaking	A	Require repair or replacement of line.
Steel line missing	C	Require replacement of line.
Steel line restricted	A	Require repair or replacement of line.
Steering coupler shield cracked	2	Suggest replacement.
Steering coupler shield missing	C	Require replacement.
Steering coupler shield torn	2	Suggest replacement.
Threads damaged	A	Require repair or replacement of part with damaged threads.

Threads stripped (threads missing)	A	Require replacement of part with stripped threads.
U-joint binding	A	Require repair or replacement of joint.
U-joint loose	A	Require repair or replacement of joint.
Unequal power assist	A	Require repair or replacement.

(1) - Determine and correct source of contamination. Follow OE specifications for fluid type.
(2) - Indicates internal wear.
(3) - If steering gear is source of inadequate assist, require repair or replacement.

STEERING KNUCKLES

STEERING KNUCKLE INSPECTION

Condition	Code	Procedure
Attaching hardware bent	B	Require repair or replacement of bent part.
Attaching hardware broken	A	Require replacement of broken part.
Attaching hardware incorrect	A	Require replacement of incorrect part.
Attaching hardware loose	A	Require repair or replacement of loose part.
Attaching hardware missing	C	Require replacement of missing part.
Attaching hardware threads damaged	A	Require repair or replacement of part with damaged threads.
Attaching hardware threads stripped (threads missing)	A	Require replacement of part with stripped threads.
Bent	B	Require replacement.
Broken	A	Require replacement.
Pinch bolt incorrect	B	Require replacement with bolt that meets OE design.
Pinch bolt loose	B	Require repair.
Pinch bolt missing	B	Require replacement.
Pinch bolt tabs deformed (pinched together), .032" or more before clamping	B	(1) Require replacement.
Taper hole elongated	A	(2) Require replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require repair or replacement.

(1) - Steering knuckle deformation can cause pinch bolt breakage.
(2) - Check for damaged stud.

STRIKE OUT BUMPERS

STRIKE OUT BUMPER INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require replacement of broken part.
Attaching hardware corroded, affecting structural integrity	A	Require replacement of corroded part.
Attaching hardware loose	A	Require repair or replacement of loose part.
Attaching hardware missing	C	Require replacement of missing part.
Attaching hardware threads damaged	A	Require repair or replacement of part with damaged threads.
Attaching hardware threads stripped (threads missing)	A	Require replacement of part with stripped threads.
Missing	C	Require replacement.
Split	1	Suggest replacement.

STRUT RODS

STRUT ROD INSPECTION

Condition	Code	Procedure
Adjusting nut seized	A	(1) Require repair or replacement.
Attaching hardware bent	B	Require repair or replacement of bent part, if available; otherwise, replace strut rod.
Attaching hardware broken	A	Require replacement of broken part, if available; otherwise, replace strut rod.
Attaching hardware incorrect	A	Require replacement of incorrect part, if available; otherwise, replace strut rod.
Attaching hardware loose	A	Require repair or replacement of loose part, if available; otherwise, replace strut rod.
Attaching hardware missing	C	Require replacement of missing part, if available; otherwise, replace strut rod.
Attaching hardware threads damaged	A	Require repair or replacement of part with damaged threads,

		if available; otherwise, replace strut rod.
Attaching hardware threads stripped (threads missing)	A	..... Require replacement of part with stripped threads, if available; otherwise, replace strut rod.
Attaching (mating) hole oversized	A	... Require repair or replacement of frame.
Attaching point on frame corroded, affecting structural integrity ...	A	.... Require repair of frame.
Bent	A	.... Require replacement.
Mating (attaching) hole oversized	A	... Require repair or replacement of frame.
Threads damaged	A	.. Require repair or replacement.
Threads stripped (threads missing)	A	.... Require replacement.

(1) - Only required if an alignment is being performed.

STRUT UPPER BEARING PLATE ASSEMBLIES

NOTE: When the following guidelines indicate replacement of bearing, only the bearing should be replaced if it is available separately; otherwise, replace the bearing plate assembly.

STRUT UPPER BEARING PLATE ASSEMBLY INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	... Require replacement of broken part, if available; otherwise, replace bearing plate assembly.
Attaching hardware loose	A	... Require repair or replacement of loose part, if available; otherwise, replace bearing plate assembly.
Attaching hardware missing	C	.. Require replacement of missing part, if available; otherwise, replace bearing plate assembly.
Attaching hardware threads damaged	A	... Require repair or replacement of part with damaged threads, if available; otherwise, replace bearing plate assembly.
Attaching hardware threads stripped (threads missing)	A	..... Require replacement of part with stripped threads, if available; otherwise, replace bearing plate assembly.
Bearing axial or radial movement exceeds vehicle manufacturer’s		

specifications	B	Require replacement of bearing.
Bearing binding	A	Require replacement of bearing.
Bearing missing	C	Require replacement of bearing.
Bearing seized	A	Require replacement of bearing.
Bent	B	Require replacement.
Holes distorted	A	Require replacement.
Missing	C	Require replacement.
Severely corroded, affecting structural integrity	A	Require replacement.

SWAY BAR LINKS

SWAY BAR LINK INSPECTION

Condition	Code	Procedure
Attaching hardware incorrect	A	Require replacement of incorrect part, if available; otherwise, replace link.
Attaching hardware loose	A	Require repair or replacement of loose part, if available; otherwise, replace link.
Attaching hardware missing	C	Require replacement of missing part, if available; otherwise, replace link.
Attaching hardware threads damaged	A	Require repair or replacement of part with damaged threads, if available; otherwise, replace link.
Attaching hardware threads stripped (threads missing)	A	Require replacement of part with stripped threads, if available; otherwise, replace link.
Ball and socket has looseness (perceptible vertical movement)	1	(1) Suggest replacement.
Ball and socket has looseness that is excessive	B	(1)(2) Require replacement.
Bent	B	Require replacement.
Broken	A	Require replacement.
Corroded, affecting structural integrity	A	Require replacement.
Grease boot cracked	2	(3) Suggest replacement.
Grease boot missing	2	(4) Suggest replacement.
Grease boot torn	2	(5) Suggest replacement.
Missing	C	Require replacement.
Nut on stud loose	A	(6) Require repair.
Stud bent	B	(7) Require replacement.
Stud broken	A	(7) Require replacement.
Threads damaged	A	Require repair or replacement.

Threads stripped (threads missing)	A	(7) Require replacement.

(1) - If manufacturer's procedures for inspection exist, use those procedures; otherwise, use an approved inspection method such as the dry park check.
CAUTION: DO NOT use pliers or pry bar to check ball and socket movement. Use only moderate hand pressure.
(2) - Excessive looseness is defined as being significant enough to affect vehicle handling or structural integrity.
(3) - Cracked grease boot will allow contaminants to enter the joint and will accelerate wear.
(4) - Lack of grease boot will allow contaminants to enter the joint and will accelerate wear.
(5) - Torn grease boot will allow contaminants to enter the joint and will accelerate wear.
(6) - Check for bent stud or damaged taper hole.
(7) - Check for damaged taper hole.

SWAY BARS

SWAY BAR INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	Require replacement of broken part, if available; otherwise, replace sway bar.
Attaching hardware corroded, affecting structural integrity	A	Require replacement of corroded part, if available; otherwise, replace sway bar.
Attaching hardware loose	A	Require repair or replacement of loose part, if available; otherwise, replace sway bar.
Attaching hardware missing	C	Require replacement of missing part, if available; otherwise, replace sway bar.
Attaching hardware threads damaged	A	Require repair or replacement of part with damaged threads, if available; otherwise, replace sway bar.
Attaching hardware threads stripped (threads missing)	A	Require replacement of part with stripped threads, if available; otherwise, replace sway bar.
Bent	B	Require replacement.
Broken	A	Require replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped (threads missing)	A	Require replacement.

TIE ROD ENDS (INNER AND OUTER)

TIE ROD END (INNER AND OUTER) INSPECTION

Condition	Code	Procedure
Attaching hardware incorrect	A	Require replacement of incorrect part, if available; otherwise, replace tie rod end.
Attaching hardware loose	A	Require repair or replacement of loose part, if available; otherwise, replace tie rod end.
Attaching hardware missing	C	Require replacement of missing part, if available; otherwise, replace tie rod end.
Attaching hardware threads damaged	A	Require repair or replacement of part with damaged threads, if available; otherwise, replace tie rod end.
Attaching hardware threads stripped (threads missing)	A	Require replacement of part with stripped threads, if available; otherwise, replace tie rod end.
Adjusting sleeve bent	B	Require replacement of sleeve or tie rod end.
Adjusting sleeve clamps out of position	B	Require repair.
Adjusting sleeve corroded, affecting structural integrity	A	Require replacement of sleeve or tie rod end.
Adjusting sleeve missing	C	Require replacement of sleeve or tie rod end.
Adjusting sleeve seized	A	(1) Require repair or replacement.
Adjusting sleeve threads damaged	A	Require repair or replacement of sleeve or tie rod end.
Adjusting sleeve threads stripped (threads missing)	A	Require replacement of sleeve or tie rod end.
Binding	A	(2) Further inspection required.
Grease boot cracked	2	(3) Suggest replacement.
Grease boot missing	2	(4) Suggest replacement.
Grease boot torn	2	(5) Suggest replacement.
Grease fitting broken	A	Require replacement of grease fitting.
Grease fitting missing	C	Require replacement of grease fitting.
Grease fitting won't seal	A	Require replacement of grease fitting.
Grease seal missing	2	(4) Suggest replacement of seal.

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Grease seal torn  ........  2  .........  (5) Suggest replacement
                                                         of seal.
Greaseable tie rod end
 won't take grease  ......  2  ......  (6) Suggest replacement of
                                                   grease fitting.
Looseness (perceptible
 horizontal movement)  ...  1  ........  (7) Suggest replacement.
Looseness exceeds
 manufacturer's
 specifications  .........  B  ...........  Require replacement.
Looseness that is
 excessive  ..............  B  .....  (7)(8) Require replacement.
Nut on stud loose  .......  A  ...........  (9) Require repair or
                                               replacement of nut.
Seized  ..................  A  .............  Require replacement
Stud bent  ...............  B  .......  (10) Require replacement.
Stud broken  .............  A  .......  (10) Require replacement.
Threads damaged  .........  A  ..  Require repair or replacement.
Threads stripped
 (threads missing)  ......  A  .......  (10) Require replacement.
```

(1) - Only required if toe needs to be adjusted.
(2) - If greaseable, grease joint. If problem persists or joint is non-greaseable, require replacement.
(3) - Cracked grease boot will allow contaminants to enter joint and will accelerate wear.
(4) - Lack of grease boot will allow contaminants to enter joint and will accelerate wear.
(5) - Torn grease boot will allow contaminants to enter joint and will accelerate wear.
(6) - If greaseable tie rod end will not take grease after replacing the grease fitting, suggest replacement of tie rod end.
(7) - If manufacturer's procedures for inspection exist, use those procedures; otherwise, use an approved inspection method such as the dry park check.
CAUTION: DO NOT use pliers or pry bar to check ball and socket movement. Use only moderate hand pressure.
(8) - Excessive looseness is defined as being significant enough to affect vehicle handling or structural integrity.
(9) - Check for bent stud or damaged taper hole.
(10) - Check for damaged taper hole.

TRACK BARS

TRACK BAR INSPECTION

```
Condition                   Code                        Procedure

Attaching hardware
 incorrect  ..............  A  ..........  Require replacement of
                                        incorrect part, if available;
                                        otherwise, replace track bar.
Attaching hardware
 loose  ..................  A  ...  Require repair or replacement
                                         of loose part, if available;
                                        otherwise, replace track bar.
Attaching hardware
 missing  ................  C  ..  Require replacement of missing
                                       part, if available; otherwise,
                                                   replace track bar.
Attaching hardware
```

threads damaged	A	... Require repair or replacement of part with damaged threads, if available; otherwise, replace track bar.
Attaching hardware threads stripped (threads missing)	A	..... Require replacement of part with stripped threads, if available; otherwise, replace track bar.
Bent	B	.... Require replacement.
Corroded, affecting structural integrity ...	A	.... Require replacement.
Grease boot cracked	2	.... (1) Suggest replacement.
Grease boot missing	2	.... (2) Suggest replacement.
Grease boot torn	2	.... (3) Suggest replacement.
Holes distorted	A	.... Require replacement.
Looseness (perceptible horizontal movement) ...	1	.... (4) Suggest replacement.
Looseness that is excessive	B	..... (4)(5) Require replacement.
Nut on stud loose	A	.... (6) Require repair or replacement of nut.
Seized	A	.... Require replacement.
Stud bent	B	.... (7) Require replacement.
Stud broken	A	.... (7) Require replacement.
Threads damaged	A	.. Require repair or replacement.
Threads stripped (threads missing)	A	.... (7) Require replacement.
Wear exceeds manufacturer's specifications	B	.... Require replacement.

(1) - Cracked grease boot will allow contaminants to enter joint and will accelerate wear.
(2) - Lack of grease boot will allow contaminants to enter joint and will accelerate wear.
(3) - Torn grease boot will allow contaminants to enter joint and will accelerate wear.
(4) - If manufacturer's procedures for inspection exist, use those procedures; otherwise, use an approved inspection method such as the dry park check.
CAUTION: DO NOT use pliers or pry bar to check ball and socket movement. Use only moderate hand pressure.
(5) - Excessive looseness is defined as being significant enough to affect vehicle handling or structural integrity.
(6) - Check for bent stud or damaged taper hole.
(7) - Check for damaged taper hole.

TRAILING ARMS

TRAILING ARM INSPECTION

Condition	Code	Procedure
Attaching hardware broken	A	... Require replacement of broken part, if available; otherwise, replace trailing arm.
Attaching hardware loose	A	... Require repair or replacement of loose part, if available;

		otherwise, replace trailing arm.
Attaching hardware missing	C	.. Require replacement of missing part, if available; otherwise, replace trailing arm.
Attaching hardware threads damaged	A	... Require repair or replacement of part with damaged threads, if available; otherwise, replace trailing arm.
Attaching hardware threads stripped (threads missing)	A	..... Require replacement of part with stripped threads, if available; otherwise, replace trailing arm.
Bent	B	.... Require replacement.
Bushing hole oversized ..	B	.... Require replacement.
Corroded, affecting structural integrity ...	A	.... Require replacement.
Holes distorted	A	.... Require replacement.
Threads damaged	A	.. Require repair or replacement.
Threads stripped (threads missing)	A	.... Require replacement.

WHEEL BEARINGS, RACES AND SEALS

NOTE: When replacing or repacking wheel bearings, grease seal replacement is required. You are not required to replace these components in axle sets. Determine the need to replace based upon the individual component conditions that follow.

WHEEL BEARING, RACE AND SEAL INSPECTION

Condition	Code	Procedure
Rear axle seal on rear-wheel drive leaking	A	..... Require replacement of seal and inspection of axle, bearing, housing, and vent tube.
Seal bent	1	.... Suggest replacement.
Seal leaking	A	. Require replacement of seal and inspection of bearings.
Seal missing	C	.... Require replacement.
Seal torn	A	.... Require replacement.
Wheel bearing assembly feels rough when rotated	A	.. Require replacement of bearing assembly.
Wheel bearing balls are pitted	A	.. Require replacement of bearing assembly.
Wheel bearing balls are worn	A	.. Require replacement of bearing assembly.
Wheel bearing end-play exceeds vehicle manufacturer's specifications	B	.. Require adjustment of bearing,

		if possible. If proper adjustment cannot be obtained, require repair or replacement of worn component.
Wheel bearing race is loose in the hub bore	A	Require replacement of hub assembly and wheel bearings.
Wheel bearing races are pitted	A	Require replacement of bearing assembly.
Wheel bearing races are worn	A	Require replacement of bearing assembly.
Wheel bearing rollers are pitted	A	Require replacement of bearing assembly.
Wheel bearing rollers are worn	A	Require replacement of bearing assembly.

WHEEL ALIGNMENT

WHEEL ALIGNMENT

Wheel alignment is defined as the measurement, analysis, and adjustment of steering and suspension angles to conform to OEM specifications. These angles usually include, but are not limited to: caster, camber, toe, and thrust angle. Where these angles are not adjustable and not in specification, component replacement or correction kits may be required. Errors in set-back and steering axis inclination (SAI) are often attributable to failed or damaged components and must be corrected prior to performing an alignment.

Failure to replace or correct suggested parts or service may prevent a proper alignment.

Before performing an alignment check, inspect and verify the following:

* Tire pressure and size
* Vehicle loading
* Ride height
* Steering and suspension parts

If the inspection reveals that all the above are within published specifications, a wheel alignment check and an alignment, if needed, may be performed.

CAUTION: Under no circumstances should a technician bend or heat any steering or suspension component, unless specified by the vehicle manufacturer, for example, Ford forged twin "I" beam axles. All measurements and specifications must be noted on the inspection report.

WHEEL ALIGNMENT INSPECTION

Condition	Code	Procedure
Dog tracking, shown to be caused by faulty alignment	2	Suggest repair.
Lead, shown to		

be caused by faulty alignment	A	Require alignment.
Part has been changed, affecting alignment	A	Require alignment check.
Pull, shown to be caused by faulty alignment	A	Require alignment.
Steering wheel off-center	2	Suggest alignment.
Tire wear, shown to be caused by faulty alignment	A	Require alignment.
Wander, shown to be caused by faulty alignment	A	Require alignment.

WHEELS AND TIRES

TIRES

These guidelines do not apply to split rims. Some vehicle manufacturers restrict replacement of tires to specific brands, types, or sizes.

WARNING: High pressure temporary compact spare tires should not be used with any other rims or wheels, nor should standard tires, snow tires, wheel covers, or trim rings be used with high pressure compact spare rims or wheels. Attempting to mount a tire of one diameter on a wheel of a different diameter or flange type may result in serious injury or death.

WARNING: Only specially trained persons should dismount or mount tires. Explosions of tire and wheel assembly can result from improper mounting, possibly causing serious injury or death.

WARNING: Consult the vehicle owner's manual or vehicle placard for correct size, speed rating, designation, and cold inflation pressure of the original tires. DO NOT exceed the maximum load or inflation capacity of the tire specified by the Tire and Rim Association

WARNING: When replacing tires, it is suggested that the replacement tires match or exceed the OEM speed rating designation. If tires of different speed rating designations are mixed on the same vehicle, the tires may vary in handling characteristics. DO NOT mix different speed rating designations on the same axle.

WARNING: DO NOT mix radials with non-radial tires on the same axle, as this may affect vehicle handling and stability. If radial tires and bias or bias-belted ply tires are mixed on the same vehicle, the radials must be on the rear. High-pressure temporary compact spare tires are exempt from this rule.

WARNING: DO NOT mix size or type (all season, performance, mud and snow) of tires on the same axle.

TIRE INSPECTION

Condition	Code	Procedure
Air pressure incorrect	B	Require repair
Bead broken	A	Require replacement.
Bead leaking, caused by tire	A	Require repair or replacement.
Bead wire/cord exposed	A	Require replacement.
Cord or belt material exposed	A	Require replacement.
Cord ply separations	A	Require replacement.
Directional/asymmetrical tires mounted incorrectly	B	Require remounting and/or repositioning.
Irregular tread wear, affecting performance	2	(1) Suggest replacement.
Load ratings less than OEM specifications	B	Require replacement.
Mixed tread types (all season, performance, mud and snow) on same axle	A	Require replacement.
Number of punctures exceeds manufacturer's limit	B	Require replacement.
Out of balance	B	Require rebalance of tire/wheel assembly.
Ply separation	A	Require replacement.
Pull or lead, caused by tire	A	Require repair or replacement.
Radial and bias or bias-belted ply tires on same axle	B	Require repair or replacement.
Radials are on the front and not on the rear	B	(2) Require repair or replacement.
Run flat damage	A	Require replacement.
Shoulder cut	A	Require replacement.
Shoulder puncture	A	Require replacement.
Shoulder with plug	A	Require replacement.
Sidewall bulge	A	Require replacement.
Sidewall cut	A	Require replacement.
Sidewall indentation	..	No service required or suggested.
Sidewall puncture	A	Require replacement.
Sidewall with plug	A	Require replacement.
Speed rating designations different on same axle	2	Suggest repair or replacement.
Tire and wheel assembly has excessive run-out	B	(3) Require repair or replacement of appropriate part.
Tires with more than 1/4" diameter difference on a four-wheel drive vehicle	B	Require replacement.
Tread area puncture larger in diameter than manufacturer's specifications	B	Require replacement.
Tread missing pieces		

Condition	Code	Procedure
(chunking), exposing cord	A	Require replacement.
Tread missing pieces (chunking), not exposing cord	1	Suggest replacement.
Tread separations	A	Require replacement.
Tube in tubeless tire	3	(4) Suggest removal of tube.
Weather-checking	..	No service required or suggested.
Worn to tread wear indicators	B	Require replacement.

(1) - Determine and correct cause of irregular tire wear.
(2) - If radials and bias or bias-belted ply tires are on the same vehicle, the radials must be on the rear axle, except for high-pressure temporary spares.
(3) - Excessive is defined as enough to contribute to performance problems. Match mounting may correct run-out. If not, require replacement of appropriate part. Refer to manufacturer's specifications.
(4) - Most manufacturers do not recommend tubes in tubeless tires. Inspect tire and wheel assembly to determine the reason for a tube in tubeless tire. Recommendation for repair or replacement should be based upon condition of tires and/or wheel listed in these guidelines.

VALVE STEMS

VALVE STEM INSPECTION

Condition	Code	Procedure
Bent	1	Suggest replacement.
Broken	A	Require replacement.
Cut, but not leaking	1	Suggest replacement.
Deteriorated (cracking, dry rot)	1	Suggest replacement.
Leaking	A	Require repair or replacement.
Missing	C	Require replacement.
Threads damaged	A	Require repair or replacement.
Threads stripped	A	Require replacement.
Valve cap missing	C	Require replacement of cap.
Weather-checking	1	Suggest replacement.
Won't take air	A	Require repair or replacement.

WHEEL ATTACHMENT HARDWARE

For conditions noted below, also check conditions of wheel stud holes.

CAUTION: Proper lug nut torque is essential. Follow recommended torque specifications and tightening sequence. DO NOT lubricate threads unless specified by the vehicle manufacturer.

WHEEL ATTACHMENT HARDWARE INSPECTION

Condition	Code	Procedure
Bent	A	Require replacement.
Broken	A	(1) Require replacement.

Loose	B	Require repair or replacement of affected component.
Lug nut installed backward	B	Require repair or replacement.
Lug nut mating type incorrect	B	Require replacement of nut.
Lug nut mating surface dished	A	Require replacement of nut.
Lug nut rounded	A	(2) Require replacement of nut.
Lug nut seized	A	(2) Require replacement of nut.
Stud incorrect	B	Require replacement of stud.
Threads damaged	A	Require repair or replacement of component with damaged threads.
Threads stripped	A	Require replacement of component with stripped threads.

(1) - Some manufacturers require replacement of all studs on that wheel if two or more studs or nuts on the same wheel are broken or missing.
(2) - Only required if removing wheel.

WHEELS (RIMS)

WARNING: Mounting a regular tire on a high-pressure compact spare wheel is not permitted. Attempting to mount a tire of one diameter on a wheel of a different diameter or flange type may result in serious injury or death. If the wheel identification stamp is not legible, or cannot be found, do not use the wheel until the size and type have been properly identified. Wheels of different diameter, offset, or width cannot be mixed on the same axle. Bead seat tapers cannot be interchanged.

WHEEL (RIM) INSPECTION

Condition	Code	Procedure
Bead leaking, caused by wheel	A	(1) Require repair or replacement.
Bent hub mounting surface	A	Require replacement.
Bent rim, causing vibration	2	(1) Suggest replacement.
Broken	A	Require replacement.
Cast wheel porous, causing a leak	A	Require repair or replacement.
Clip-on balance weight is incorrect type for rim flange	2	Suggest replacement.
Corrosion, affecting structural integrity	A	Require replacement.
Corrosion build-up on wheel mounting surface	A	Require repair.
Cracked	A	Require replacement.
Directional/asymmetrical wheels mounted incorrectly	B	Require remounting and/or repositioning.

Load capacity less than OEM specifications	B	Require replacement.
Offset mismatched on same axle	B	Require replacement.
Rivets leaking	A	Require replacement.
Run-out beyond OEM specs	B	Require replacement.
Stud holes elongated	A	(2) Require replacement.
Welded or brazed repair	2	Suggest replacement.
Welds leaking	A	Require replacement.
Wheel centering (pilot) hole incorrect	B	Require replacement.

(1) - CAUTION: DO NOT attempt to correct a bent rim.
(2) - Inspect wheel attaching hardware for damage.

* SYMPTOM CHECK LIST *

1988 Jeep Cherokee

SYMPTOM CHECK LIST WORKSHEETS

* PLEASE READ THIS FIRST *

NOTE: This article is intended for general information purposes only. It does not apply specifically to one make or model.

PURPOSE

Why Use the Symptom Check List Worksheets?

One of the most difficult and critical lines of communication is between the service customer and the technician. The clearer the technician understands the customer's concerns, the more likely the problem will be "fixed right the first time".

The Symptom Check List Worksheets in this article are designed to improve this communication. When used consistently, they can be helpful in reducing shop comebacks, increasing technician productivity, and producing satisfied customers. They also provide other benefits:

* Reduce "No Trouble Found" problems
* Increase customer involvement
* Customer perceive that "they really care and listen"
* Save time during peak write-up periods
* Reduce recontacting customers for additional information
* Improve night drop information
* Insure all the right questions are asked at write-up

Making the Worksheets a Part of Your Normal Routine

The following information contains ideas that may be helpful in forming habits that promote daily use of the Symptom Check Lists:

* HAVE THE SERVICE ADVISER FILL OUT THE FORM(S) WITH THE CUSTOMER WHENEVER POSSIBLE.
* Place them in your night drop for the customer to fill out, along with an instruction sheet to help them understand what to do.
* Hand out the worksheets to customers while they wait in line during the peak morning rush and ask them to fill it out. It will save time for all concerned and improve the quality of information received from the customer.
* Make sure it is attached to the hard copy when it goes to the technician.
* Place a copy with the final repair papers and review it with the customer at delivery.
* Put a new worksheet in the glovebox of all departing customers.
* Require that you personally see a copy of all worksheets filled out for shop comebacks.
* Hold a shop meeting to get employee buy-in and their ideas on how to make it effective in your shop.

There are many other ways to utilize the concept, but as with every other idea, successful implementation depends on employee involvement and buy-in.

SYMPTOM CHECK LIST WORKSHEETS

CONDENSED VERSION - ALL ON ONE PAGE

NOTE: Have the service adviser fill out this form with the customer whenever possible.

DRIVEABILITY WORKSHEET

(To Be Filled Out By Vehicle Owner)

Name: ______________________ **Date:** ________ **Make:** ____________

Model: ____________ **Year:** ____________ **Engine:** __________ **Mileage:** ________

FAULT CHARACTERISTICS – SYMPTOMS – DESCRIPTION OF PROBLEM	(Please Check All That Apply In All Categories)
Starting Problems	☐ Will Not Crank ☐ Cranks, But Won't Start ☐ Starts, But Takes A Long Time
Engine Quits/ Running Problems	**Quits:** ☐ Right After Starting ☐ When Put Into Gear ☐ Right After Vehicle Comes To A Stop ☐ During Steady Speed Driving ☐ While Idling ☐ During Acceleration ☐ When Parking
Poor Idling Conditions	**Idle Speed:** ☐ Is Too Slow At All Times ☐ Is Too Slow With A/C On ☐ Is Too Fast ☐ Is Rough Or Uneven ☐ Fluctuates Up and Down
Poor Running Conditions	☐ Runs Rough ☐ Lacks Power ☐ Hesitates Or Stumbles On Acceleration ☐ Bucks and Jerks ☐ Engine Knocks, Pings, Rattles ☐ Backfires ☐ Poor Fuel Economy ☐ Misfires or Cuts Out ☐ Surges and/or Chuggles ☐ Dieseling or Run-On ☐ Engine Light Always On ☐ Engine Light On Sometimes ☐ Fuel, Gas, or Sulfur Smell
Auto. Transmission Problems	☐ Improper Shifting (early/late) ☐ Changes Gear Randomly On Its Own ☐ Vehicle Does Not Move When In Gear
Poor Handling	☐ Pulls To One Side ☐ Hard Steering ☐ Vehicle Shakes and/or Vibrates While Moving
Noise Problems	**Explain:**
Odor Problems	**Explain:**
Problem Frequency	☐ Always ☐ Often ☐ Occasionally
Usually Occurs	☐ Morning ☐ Afternoon ☐ Anytime
Engine Temp.	☐ Cold ☐ Warm ☐ Hot
Vehicle Speed	☐ Low ☐ Cruising ☐ High
Driving Conditions During Occurrence	☐ Short – Less Than 2 Miles ☐ 2-10 Miles ☐ Long – More Than 10 Miles ☐ Stop & Go ☐ While Turning ☐ While Braking ☐ At Gear Engagement ☐ With A/C Operating ☐ With Headlights On ☐ During Acceleration ☐ During Deceleration ☐ Mostly Downhill ☐ Mostly Uphill ☐ Mostly Level ☐ Mostly Curvy ☐ Rough Road
Driving Habits	☐ Drive Hard Before Engine Is Warmed ☐ Allow Engine To Warm ☐ Mostly City Driving ☐ Highway ☐ Park Vehicle Inside ☐ Outside **Drive Per Day:** ☐ Less Than 10 Miles ☐ 10-50 ☐ More Than 50 **Fuel Octane:** ☐ 87 ☐ 89 ☐ 91 ☐ More Than 91 **Brand:** ________ ☐ Gasohol ☐ Propane Conversion
Outside Weather	☐ Cold ☐ Warm ☐ Hot ☐ Wet/Rainy ☐ Fog ☐ Snow/Hail ☐ Dust/Dirt ☐ Dry ☐ Humid

Fig. 1: Entire Vehicle - Symptom Check List For Customer

FULL VERSION - ALL ON FOUR PAGES

NOTE: Have the service adviser fill out these forms with the

customer whenever possible.

Dear Valued Customer:

Our goal is to fix your problem correctly and get you back on the road as soon as possible in the unlikely event you experience a problem with your vehicle. Help us identify the exact nature of the concern by taking a few moments to complete the appropriate section of this diagnostic worksheet. Thank you.

CUSTOMER NAME: ____ **PHONE NO.:** ____ **REPAIR ORDER NO.:** ____

DIAGNOSTIC WORKSHEET

DRIVEABILITY - ENGINE - AUTOMATIC TRANSMISSION

SYMPTOM (CHECK ALL THAT APPLY)

ENGINE

- ☐ "Service Engine Soon"/"Malfunction Indicator Light" on
- ☐ Hard start/no start (cranks OK)
- ☐ Won't crank
- ☐ Engine stalls
- ☐ Engine miss
- ☐ Miss while driving
- ☐ Hesitates, stumbles or sags
- ☐ Rough idle
- ☐ Idle is too high ☐ Idle is too low
- ☐ Poor power/performance
- ☐ Surge or chuggle, buck - jerk - skip
- ☐ Poor gas mileage ☐ Highway ☐ City
- ☐ Pings, detonates
- ☐ Suphur, rotten egg odor
- ☐ Backfires (popping noise) - underhood/tailpipe
- ☐ Exhaust smoke ☐ Increased oil consumption
- ☐ Runs on after key is turned off
- ☐ Speed fluctuates without moving accelerator
- ☐ Engine noise (explain): ____

(whine, rattle, groan, clunk, etc.)

- ☐ Other: ____

TRANSMISSION

- ☐ Does not shift properly ☐ Hard shift
- ☐ Will not shift ☐ Up ☐ Down
- ☐ Will not shift into overdrive
- ☐ Engine starts in other than "P" or "N"
- ☐ Noise (describe): ____

(whine, rattle, groan, clunk, buzz, etc.)

- ☐ Shifts into gear too early
- ☐ Overdrive doesn't work with speed control, but is otherwise OK
- ☐ Highway speed - shudder, surge, etc.
- ☐ Other: ____

EXPLAIN: ____

OPERATING CONDITIONS (CHECK ALL THAT APPLY)

HOW OFTEN DOES IT OCCUR? (Engine and/or Transmission)

- ☐ Always ☐ Few seconds ☐ Few minutes
- ☐ Few hours ☐ Few days ☐ Few weeks
- ☐ Few months ☐ Variable ☐ Only during event
- ☐ Every ____ to ____ miles ☐ Unknown
- ☐ Other (explain): ____
- ☐ Just started ☐ Getting better ☐ Getting worse
- ☐ Since new

WHEN DOES IT OCCUR? (Engine and/or Transmission)

When Engine Temperature is:

- ☐ Cold ☐ Warm ☐ Hot
- ☐ All the time ☐ Only during warmup

Weather Conditions:

- ☐ Very cold - below 0 degrees F ☐ Cold - 0 to 32 degrees F
- ☐ Cool - 32 to 60 degrees F ☐ Warm - 60 to 80 degrees F
- ☐ Hot - Above 80 degrees F ☐ Any environment
- ☐ Raining ☐ Dry ☐ Humid
- ☐ Snow/ice ☐ Wet roads ☐ Other (explain below)

Driving Conditions:

- ☐ Light throttle ☐ Medium throttle ☐ Hard throttle
- ☐ Starting ☐ At idle ☐ Decelerating
- ☐ Over bumps ☐ When shifting ☐ While turning
- ☐ Cruising steady at ____ MPH ☐ While braking
- ☐ Anytime ☐ Uphill ☐ Downhill
- ☐ Highway ☐ City/town ☐ Stop and go
- ☐ Between ____ MPH and ____ MPH
- ☐ Only with A/C or Defrost on

What Type of Fuel? **What Brand?** ____

- ☐ Regular UL ☐ Mid range UL ☐ Premium Unleaded
- ☐ Gasohol ☐ Ethanol ☐ Methanol
- ☐ Diesel #1 ☐ Diesel #2 ☐ Various brands

When Gear Selector is in:

- ☐ Park/Neutral ☐ Reverse ☐ Overdrive
- ☐ Drive/3 ☐ Drive/2 ☐ Drive/1

Between Gears:

- ☐ Park to R or D ☐ Rev/Drive ☐ First/Second
- ☐ Second/Third ☐ Third/Overdrive

50G15061

Fig. 2: Symptom Check List - Page 1

BRAKES - STEERING - SUSPENSION

SYMPTOM

- ☐ Vehicle pulls right - When ____________
- ☐ Vehicle pulls left - When ____________
- ☐ Steering wheel vibrates at ____ MPH
- ☐ Excessive play in steering
- ☐ Erratic steering when braking
- ☐ Poor steering wheel return after cornering
- ☐ Suspension bottoms out
- ☐ Leans or sways in corners
- ☐ Brake light on
- ☐ Traction control light on
- ☐ Uneven tire wear
- ☐ Sits uneven
- ☐ "Dog" tracks
- ☐ ABS light on
- ☐ Soft ride

Hard to steer

- ☐ Effort
- ☐ Wanders
- ☐ Steering wheel off center

Shimmy/vibration (check box below for location)

- ☐ Front
- ☐ Rear
- ☐ Don't know
- ☐ Seat
- ☐ Floor
- ☐ Other ____________

Brake pedal

- ☐ Noise
- ☐ Pulses
- ☐ Squeaks
- ☐ Hard
- ☐ Mushy
- ☐ Excessive travel

WHEN DOES IT OCCUR?

- ☐ Cold days
- ☐ Hot days
- ☐ Wet/rain
- ☐ All the time
- ☐ Intermittent
- ☐ Parking manuevers
- ☐ At road speed
- ☐ Accelerating
- ☐ Decelerating

EXPLAIN: ____________

SQUEAK - RATTLE - NOISE CONDITIONS

AREA OF NOISE

☐ Engine Compartment	☐ Left	☐ Right	☐ Center	☐ Don't know
☐ Front Suspension	☐ Left	☐ Right	☐ Center	☐ Don't know
☐ Rear Suspension	☐ Left	☐ Right	☐ Center	☐ Don't know
☐ Passenger Compartment	☐ Left	☐ Right	☐ Center	☐ Don't know
☐ Instrument Panel	☐ Left	☐ Right	☐ Center	☐ Don't know
☐ Doors	☐ Left	☐ Right	☐ Center	☐ Don't know
☐ Rear seat area	☐ Console	☐ Other ____________		

NOISE SOUNDS LIKE

- ☐ Knocks
- ☐ Hard metal
- ☐ Light metal
- ☐ Roars
- ☐ Ticking
- ☐ Whine
- ☐ Squeaks
- ☐ Rattles
- ☐ Scraping
- ☐ Other ____________

HOW OFTEN DOES IT OCCUR?

- ☐ Continuous
- ☐ Often
- ☐ Intermittent
- ☐ Just started
- ☐ Since new

WHEN DOES IT OCCUR?

- ☐ All the time
- ☐ Speed
- ☐ RPM
- ☐ Only moving
- ☐ On turns
- ☐ Braking
- ☐ Hard throttle
- ☐ Light throttle
- ☐ Decelerate
- ☐ Steady speed
- ☐ Idle in gear
- ☐ Idle out of gear
- ☐ Hot days
- ☐ Cold days
- ☐ Humid or rainy
- ☐ Temperature ____________
- ☐ Heavy bumps
- ☐ Light bumps
- ☐ Smooth pavement

EXPLAIN: ____________

CUSTOMER NAME: **PHONE NO.:** **REPAIR ORDER NO:**

SHOP USE ONLY:

VIN#: **MILES:** **TECHNICIAN:** **ADVISOR#:**

50H15062

Fig. 3: Symptom Check List - Page 2

AIR CONDITIONING - HEATER - VENTILATION

SYSTEM OR AREA AFFECTED

☐ Air conditioner ☐ Heater ☐ Defroster ☐ Vent ☐ Bi-Level ☐ Fan/blower
☐ Max A/C ☐ Automatic Temperature Control ☐ Mix/blend ☐ Economy ☐ All

SYMPTOM

☐ Does not work ☐ Blows wrong temperature air ☐ No air comes out of vents ☐ Rapid cycling
☐ Noisy (explain) ☐ Broken ☐ Odor ☐ Air comes from wrong outlets ☐ Blows fuse
☐ Leaks ☐ Insufficient heat or cool ☐ Other (explain below)

WHEN DOES IT OCCUR?

☐ All the time ☐ Hot ☐ Cold ☐ Intermittent ☐ Right after startup
☐ When change controls only ☐ Other (explain below) ☐ Fan blower speed High / Med / Low

EXPLAIN: ____

____

ELECTRICAL - RADIO - TAPE/CD PLAYER

SYMPTOM - MUSIC SYSTEM

☐ Does not work ☐ Noisy ☐ Static ☐ Won't load ☐ Won't eject ☐ Poor reception
☐ Controls do not work ☐ Blows fuse ☐ Other (explain below)

SYSTEM AFFECTED

☐ Radio only ☐ AM ☐ FM ☐ FM stereo ☐ Graphic equalizer
☐ Tape player ☐ CD player ☐ Whole system ☐ Steering wheel buttons ☐ Phone
☐ Speakers ☐ Front ☐ Rear ☐ Left ☐ Right
☐ Antenna ☐ Clock ☐ Radio or player controls ☐ Rear seat controls

ALL OTHER ELECTRICAL ITEMS OR ACCESSORIES
Please list the complaint accessory or item and check any applicable symptom(s) from the list that follows:

______________ ☐ Inoperable ☐ Noisy ☐ No control ☐ Erratic
☐ Check light on or flashing ☐ Works improperly (explain below)
☐ Blows fuse ☐ Intermittent ☐ Related system affected (explain below)

______________ ☐ Inoperable ☐ Noisy ☐ No control ☐ Erratic
☐ Check light on or flashing ☐ Works improperly (explain below)
☐ Blows fuse ☐ Intermittent ☐ Related system affected (explain below)

______________ ☐ Inoperable ☐ Noisy ☐ No control ☐ Erratic
☐ Check light on or flashing ☐ Works improperly (explain below)
☐ Blows fuse ☐ Intermittent ☐ Related system affected (explain below)

WHEN DOES IT OCCUR?

☐ All the time ☐ Hot ☐ Cold ☐ Just after starting - malfunctions for a while
☐ Intermittent ☐ After runs for ______ minutes ☐ Rough roads or bumps only
☐ Other (explain below)

EXPLAIN: ____

____

CUSTOMER NAME: **PHONE NO.:** **REPAIR ORDER NO:**

SHOP USE ONLY:
VIN#: **MILES:** **TECHNICIAN:** **ADVISOR#:**

50115063

Fig. 4: Symptom Check List - Page 3

WATER LEAK - WINDNOISE

WATER LEAK
Leak Occurs When?

- ☐ Setting level ☐ Any time it rains ☐ While driving in the rain ☐ Car wash only
- ☐ Back lower than front (facing uphill) ☐ Front lower than back (facing downhill)

Location of Leak (where water appears):

- ☐ LF Door ☐ RF Door ☐ LR Door ☐ RR Door ☐ Windshield ☐ Rear window
- ☐ LF window ☐ RF window ☐ LR window ☐ RR window ☐ Side door ☐ Sunroof/T-Top
- ☐ Under instrument panel ☐ Rear door/rear hatch

WINDNOISE:
Location:

- ☐ LF Door ☐ RF Door ☐ LR Door ☐ RR Door ☐ Windshield ☐ Rear window
- ☐ LF window ☐ RF window ☐ LR window ☐ RR window ☐ Side door ☐ Sunroof/T-Top
- ☐ Under instrument panel ☐ Rear door/rear hatch

EXPLAIN: ______________________________

MANUAL TRANSMISSION - CLUTCH

SYMPTOM - MANUAL GEAR SHIFT

- ☐ Hard to shift ☐ Doesn't shift
- ☐ Grinds going into_____ gear
- ☐ Noisy when in _____ gear or neutral _____
- ☐ Slips/pops out of gear
- ☐ Noise (describe): ______________________________
- ☐ Upshift light stays on
- ☐ Upshift light doesn't light

WHEN DOES IT OCCUR?

- ☐ All the time ☐ Light load
- ☐ Heavy load

SYMPTOM - CLUTCH

- ☐ Hard to push ☐ Fail to release
- ☐ Noise when pressing pedal down (describe): ______________________________
- ☐ Slips ☐ Chattering (grabbing)
- ☐ Odor present ☐ Pedal stays on the floor
- ☐ Squealing sound

WHEN DOES IT OCCUR?
When Engine Temperature is:

- ☐ Cold ☐ Hot
- ☐ Accelerating ☐ Decelerating

EXPLAIN: ______________________________

COMMENTS:

____

CUSTOMER NAME: **PHONE NO.:** **REPAIR ORDER NO:**

SHOP USE ONLY:
VIN#: **MILES:** **TECHNICIAN:** **ADVISOR#:**

50J15064

Fig. 5: Symptom Check List - Page 4

INDIVIDUAL SYSTEM-BASED CHECK LISTS

NOTE: Have the service adviser fill out these forms with the customer whenever possible.

DRIVEABILITY - ENGINE - AUTOMATIC TRANSMISSION

SYMPTOM (CHECK ALL THAT APPLY) ENGINE

- ☐ "Service Engine Soon"/Malfunction Indicator Light" on
- ☐ Hard start/no start (cranks OK)
- ☐ Won't crank
- ☐ Engine stalls
- ☐ Engine miss
- ☐ Miss while driving
- ☐ Hesitates, stumbles or sags
- ☐ Rough idle
- ☐ Idle is too high ☐ Idle is too low
- ☐ Poor power/performance
- ☐ Surge or chuggle, buck - jerk - skip
- ☐ Poor gas mileage ☐ Highway ☐ City
- ☐ Ping, detonates
- ☐ Sulphur/rotten egg odor
- ☐ Backfires (popping noise) - underhood/tailpipe
- ☐ Exhaust smoke ☐ Increased oil consumption
- ☐ Runs on after key is turned off
- ☐ Speed fluctuates without moving accelerator
- ☐ Engine noise (explain): ____________

(whine, rattle, groan, clunk, etc.)

- ☐ Other: ____________

TRANSMISSION

- ☐ Does not shift properly ☐ Hard shift
- ☐ Will not shift ☐ Up ☐ Down
- ☐ Will not shift into overdrive
- ☐ Engine starts in other than "P" or "N"
- ☐ Noise (describe): ____________

(whine, rattle, groan, clunk, buzz, etc.)

- ☐ Shifts into next gear too early
- ☐ Overdrive doesn't work with speed control, but is otherwise OK
- ☐ Highway speed - shudder, surge, etc.
- ☐ Other: ____________

EXPLAIN: ____________

OPERATING CONDITIONS (CHECK ALL THAT APPLY)
HOW OFTEN DOES IT OCCUR? (Engine &/or Transmission)

- ☐ Always ☐ Few Seconds ☐ Few minutes
- ☐ Few hours ☐ Few days ☐ Few weeks
- ☐ Few months ☐ Variable ☐ Only during event
- ☐ Every ________ to ____ miles ☐ Unknown
- ☐ Other (explain): ____________
- ☐ Just started ☐ Getting better ☐ Getting worse
- ☐ Since new

WHEN DOES IT OCCUR? (Engine and/or Transmission)
When Engine Temperature is:

- ☐ Cold ☐ Warm ☐ Hot
- ☐ All the time ☐ Only during warmup

Weather Conditions:

- ☐ Very cold - below 0°F ☐ Cold - 0 to 32°F
- ☐ Cool - 32 to 60°F ☐ Warm - 60 to 80°F
- ☐ Hot - above 80°F ☐ Any environment
- ☐ Raining ☐ Dry ☐ Humid
- ☐ Snow/Ice ☐ Wet roads
- ☐ Other (explain): ____________

Driving Conditions:

- ☐ Light throttle ☐ Medium throttle ☐ Hard throttle
- ☐ Starting ☐ At idle ☐ Decelerating
- ☐ Over bumps ☐ When shifting ☐ While turning
- ☐ Cruising - steady at MPH ☐ While braking
- ☐ Anytime ☐ Uphill ☐ Downhill
- ☐ Highway ☐ City/town ☐ Stop and go
- ☐ Between ____ MPH and _____ MPH
- ☐ Only with A/C or Defrost on

What Type of Fuel? **What Brand?**

- ☐ Regular UL ☐ Midrange UL ☐ Premium UL
- ☐ Gasohol ☐ Ethanol ☐ Methanol
- ☐ Diesel #1 ☐ Diesel #2 ☐ Various brands

When Gear Selector is in:

- ☐ Park/Neutral ☐ Reverse ☐ Overdrive
- ☐ Drive/3 ☐ Drive/2 ☐ Drive/1

Between Gears:

- ☐ Park to R or D ☐ Reverse/Drive ☐ First/Second
- ☐ Second/Third ☐ Third/Overdrive

CUSTOMER NAME: **PHONE NO.:** **REPAIR ORDER NO:**

SHOP USE ONLY:

VIN#: **MILES:** **TECHNICIAN:** **ADVISOR#:**

50H15054

Fig. 6: Engine Driveability & Automatic Transmission

BRAKES - STEERING - SUSPENSION

SYMPTOM

☐ Vehicle pulls right - When ____________
☐ Vehicle pulls left - When ____________
☐ Steering wheel vibrates at ____ MPH
☐ Excessive play in steering
☐ Erratic steering when braking
☐ Poor steering wheel return after cornering
☐ Suspension bottoms out
☐ Leans or sways in corners
☐ Brake light on
☐ Traction control light on
☐ Uneven tire wear
☐ Sits uneven
☐ "Dog" tracks
☐ ABS light on
☐ Soft ride

Hard to steer

☐ Effort ☐ Wanders
☐ Steering wheel off center

Shimmy/vibration (check box below for location)

☐ Front ☐ Rear ☐ Don't know
☐ Seat ☐ Floor ☐ Other ________

Brake pedal

☐ Noise ☐ Pulses ☐ Squeaks ☐ Hard ☐ Mushy ☐ Excessive travel

WHEN DOES IT OCCUR?

☐ Cold days ☐ Hot days ☐ Wet/rain ☐ All the time ☐ Intermittent
☐ Parking manuevers ☐ At road speed ☐ Accelerating ☐ Decelerating

EXPLAIN: ____

CUSTOMER NAME: **PHONE NO.:** **REPAIR ORDER NO:**

SHOP USE ONLY:
VIN#: **MILES:** **TECHNICIAN:** **ADVISOR#:**

50C15059

Fig. 7: Brakes, Steering, & Suspension

AIR CONDITIONING - HEATER - VENTILATION

SYSTEM OR AREA AFFECTED

☐ Air conditioner ☐ Heater ☐ Defroster ☐ Vent ☐ Bi-Level ☐ Fan/blower
☐ Max A/C ☐ Automatic Temperature Control ☐ Mix/blend ☐ Economy ☐ All

SYMPTOM

☐ Does not work ☐ Blows wrong temperature air ☐ No air comes out of vents ☐ Rapid cycling
☐ Noisy (explain) ☐ Broken ☐ Odor ☐ Air comes from wrong outlets ☐ Blows fuse
☐ Leaks ☐ Insufficient heat or cool ☐ Other (explain below)

WHEN DOES IT OCCUR?

☐ All the time ☐ Hot ☐ Cold ☐ Intermittent ☐ Right after startup
☐ When change controls only ☐ Other (explain below) ☐ Fan blower speed High / Med / Low

EXPLAIN: ____

CUSTOMER NAME: **PHONE NO.:** **REPAIR ORDER NO:**

SHOP USE ONLY:
VIN#: **MILES:** **TECHNICIAN:** **ADVISOR#:**

50A15057

Fig. 8: Air Conditioning, Heater & Ventilation

ELECTRICAL - RADIO - TAPE/CD PLAYER

SYMPTOM - MUSIC SYSTEM

☐ Does not work ☐ Noisy ☐ Static ☐ Won't load ☐ Won't eject ☐ Poor reception
☐ Controls do not work ☐ Blows fuse ☐ Other (explain below)

SYSTEM AFFECTED

☐ Radio only ☐ AM ☐ FM ☐ FM stereo ☐ Graphic equalizer
☐ Tape player ☐ CD player ☐ Whole system ☐ Steering wheel buttons ☐ Phone
☐ Speakers ☐ Front ☐ Rear ☐ Left ☐ Right
☐ Antenna ☐ Clock ☐ Radio or player controls ☐ Rear seat controls

ALL OTHER ELECTRICAL ITEMS OR ACCESSORIES
Please list the complaint accessory or item and check any applicable symptom(s) from the list that follows:

______________________ ☐ Inoperable ☐ Noisy ☐ No control ☐ Erratic
☐ Check light on or flashing ☐ Works improperly (explain below)
☐ Blows fuse ☐ Intermittent ☐ Related system affected (explain below)

______________________ ☐ Inoperable ☐ Noisy ☐ No control ☐ Erratic
☐ Check light on or flashing ☐ Works improperly (explain below)
☐ Blows fuse ☐ Intermittent ☐ Related system affected (explain below)

______________________ ☐ Inoperable ☐ Noisy ☐ No control ☐ Erratic
☐ Check light on or flashing ☐ Works improperly (explain below)
☐ Blows fuse ☐ Intermittent ☐ Related system affected (explain below)

WHEN DOES IT OCCUR?

☐ All the time ☐ Hot ☐ Cold ☐ Just after starting - malfunctions for a while
☐ Intermittent ☐ After runs for ______ minutes ☐ Rough roads or bumps only
☐ Other (explain below)

EXPLAIN: ____

CUSTOMER NAME: **PHONE NO.:** **REPAIR ORDER NO:**

SHOP USE ONLY:
VIN#: **MILES:** **TECHNICIAN:** **ADVISOR#:**

50B15058

Fig. 9: Electrical, Radio & Tape/CD Player

MANUAL TRANSMISSION - CLUTCH

SYMPTOM - MANUAL GEAR SHIFT

☐ Hard to shift ☐ Doesn't shift
☐ Grinds going into_____ gear
☐ Noisy when in _______ gear or neutral _____
☐ Slips/pops out of gear
☐ Noise (describe): ______________________________
____
____

☐ Upshift light stays on
☐ Upshift light doesn't light

WHEN DOES IT OCCUR?

☐ All the time ☐ Light load
☐ Heavy load

SYMPTOM - CLUTCH

☐ Hard to push ☐ Fail to release
☐ Noise when pressing pedal down (describe): _________
____
____

☐ Slips ☐ Chattering (grabbing)
☐ Odor present ☐ Pedal stays on the floor
☐ Squealing sound

WHEN DOES IT OCCUR?

When Engine Temperature is:

☐ Cold ☐ Hot
☐ Accelerating ☐ Decelerating

EXPLAIN: ____
____
____
____
____
____

CUSTOMER NAME: **PHONE NO.:** **REPAIR ORDER NO:**

SHOP USE ONLY:
VIN#: **MILES:** **TECHNICIAN:** **ADVISOR#:**

50J15056

Fig. 10: Manual Transmission & Clutch

SQUEAK - RATTLE - NOISE CONDITIONS

AREA OF NOISE

☐ Engine Compartment	☐ Left	☐ Right	☐ Center	☐ Don't know
☐ Front Suspension	☐ Left	☐ Right	☐ Center	☐ Don't know
☐ Rear Suspension	☐ Left	☐ Right	☐ Center	☐ Don't know
☐ Passenger Compartment	☐ Left	☐ Right	☐ Center	☐ Don't know
☐ Instrument Panel	☐ Left	☐ Right	☐ Center	☐ Don't know
☐ Doors	☐ Left	☐ Right	☐ Center	☐ Don't know
☐ Rear seat area	☐ Console	☐ Other ____________________		

NOISE SOUNDS LIKE

☐ Knocks	☐ Hard metal	☐ Light metal	☐ Roars	☐ Ticking	☐ Whine
☐ Squeaks	☐ Rattles	☐ Scraping	☐ Other ______________		

HOW OFTEN DOES IT OCCUR?

☐ Continuous ☐ Often ☐ Intermittent ☐ Just started ☐ Since new

WHEN DOES IT OCCUR?

☐ All the time	☐ Speed	☐ RPM	☐ Only moving	☐ On turns	☐ Braking
☐ Hard throttle	☐ Light throttle	☐ Decelerate	☐ Steady speed	☐ Idle in gear	☐ Idle out of gear
☐ Hot days	☐ Cold days	☐ Humid or rainy	☐ Temperature ________		
☐ Heavy bumps	☐ Light bumps	☐ Smooth pavement			

EXPLAIN: ____

____

____

____

CUSTOMER NAME: **PHONE NO.:** **REPAIR ORDER NO:**

SHOP USE ONLY:

VIN#: **MILES:** **TECHNICIAN:** **ADVISOR#:**

50F15060

Fig. 11: Squeak, Rattle, & Noise Conditions

WATER LEAK - WINDNOISE

WATER LEAK

Leak Occurs When?

☐ Setting level ☐ Any time it rains ☐ While driving in the rain ☐ Car wash only

☐ Back lower than front (facing uphill) ☐ Front lower than back (facing downhill)

Location of Leak (where water appears):

☐ LF Door	☐ RF Door	☐ LR Door	☐ RR Door	☐ Windshield	☐ Rear window
☐ LF window	☐ RF window	☐ LR window	☐ RR window	☐ Side door	☐ Sunroof/T-Top
☐ Under instrument panel			☐ Rear door/rear hatch		

WINDNOISE:

Location:

☐ LF Door	☐ RF Door	☐ LR Door	☐ RR Door	☐ Windshield	☐ Rear window
☐ LF window	☐ RF window	☐ LR window	☐ RR window	☐ Side door	☐ Sunroof/T-Top
☐ Under instrument panel			☐ Rear door/rear hatch		

EXPLAIN: ____

____

____

CUSTOMER NAME: **PHONE NO.:** **REPAIR ORDER NO:**

SHOP USE ONLY:

VIN#: **MILES:** **TECHNICIAN:** **ADVISOR#:**

50I15055

Fig. 12: Water Leak & Wind Noise

TRANSFER CASE - COMMAND TRAC DIAGNOSIS

1988 Jeep Cherokee

1984-90 Drive Axles - Transfer Case - Electronic Diagnosis

Cherokee, Wagoneer, Wrangler (1987-90)

VACUUM CONTROL SYSTEM

The Command-Trac vacuum switch consists of a vacuum control switch on the transfer case, an air vent filter, a vacuum shift motor (located on front axle), a four-wheel drive indicator light and vacuum switch, two vacuum check valves and an interconnecting vacuum harness. See Fig. 1.

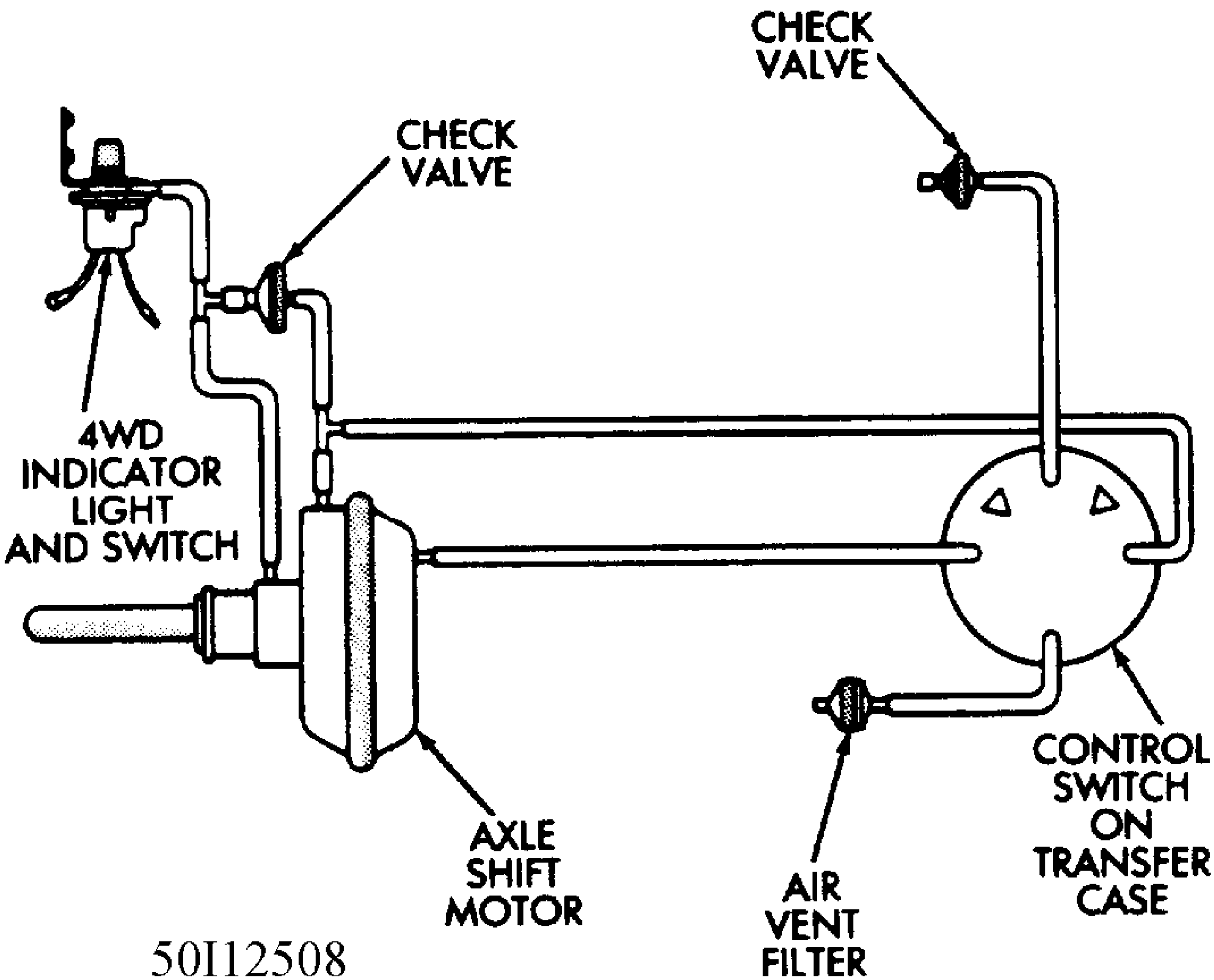


Fig. 1: Command-Trac Vacuum Control System

AXLE SHIFT MOTOR FUNCTIONAL TEST

1) Raise vehicle. Disconnect vacuum harness from axle shift motor and connect a vacuum pump to vacuum shift motor port. See Fig. 2.

2) Apply 15 in. Hg. (51 kPa) of vacuum to front port and rotate right front wheel to fully disengage outer and intermediate axle shafts (i.g., into two wheel drive operation).

3) The shift motor should maintain vacuum applied to front port for a minimum of 30 seconds. If motor does not maintain vacuum, replace it. If motor does maintain vacuum, proceed to next step.

4) Disconnect vacuum pump from vacuum shift motor front port. See Fig. 2. Connect vacuum pump to vacuum shift motor rear port, cap port for indicator lamp sw., and apply 15 in. Hg (51 kPa) of vacuum to rear port.

5) The shift motor should maintain the vacuum applied to rear port for a minimum of 30 seconds. If shift motor does not maintain vacuum, replace it. If motor does maintain vacuum, proceed to next step.

6) Remove cap from port for indicator lamp sw. and determine if vacuum was present at this port. If vacuum was present, the shift motor functions normally. If vacuum was not present, proceed to next step.

7) Apply 15 in. Hg. (51 kPa) of vacuum to shift motor rear port. Rotate right front wheel as necessary and ensure that outer and intermediate axle shafts are completely engaged. The axles must be completely engaged (i.e. into four-wheel drive operation) to open port for indicator lamp switch.

8) Determine if vacuum is present at port for indicator lamp switch again. If vacuum was present at por, shift motor functions normally. If vacuum was not present at port, replace shift motor.

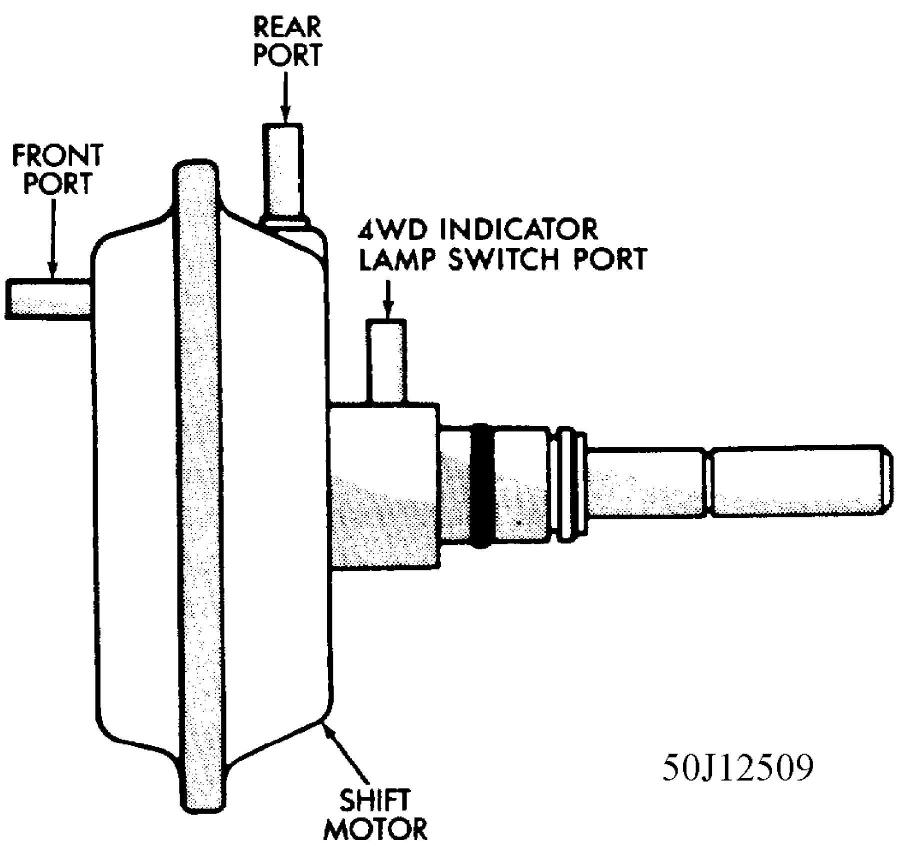


Fig. 2: Axle Vacuum Shift Motor

AXLE SHIFT MOTOR AND HOUSING REMOVAL & INSTALLATION

REMOVAL (60/70 SERIES AND MODEL 81 VEHICLES)

1) Raise and support vehicle. Position a drain pan under shift motor housing.

2) Disconnect vacuum harness.

3) Remove housing attaching bolts. Remove housing, motor and shift fork as a unit. See Fig. 3.

4) Mark shift fork and housing for installation reference.

5) Rotate shift motor and remove shift fork and motor retaining snap rings.

6) Remove shift motor from housing.

7) Remove O-ring seal from shift motor shaft. See Fig. 4. Discard O-ring seal.

INSTALLATION (60/70 SERIES AND MODEL 81 VEHICLES)

1) Add 5 ounces (148 ml) of SAE 75W-90 grade GL 5 gear lubricant to axle through shift motor housing opening.

2) Insatll a replacement O-ring seal on shift motor shaft. See Fig. 4.

3) Insatll shift motor in housing with retaining snap rings and slide shift fork onto shaft with reference mark aligned.

4) Engage shift fork with shift collar and install housing attaching bolts. See Fig. 3. Tighten bolts with 101 inch-lbs. (11 N.m) torque.

5) Connect vacuum harness to shift motor and lower vehicle.

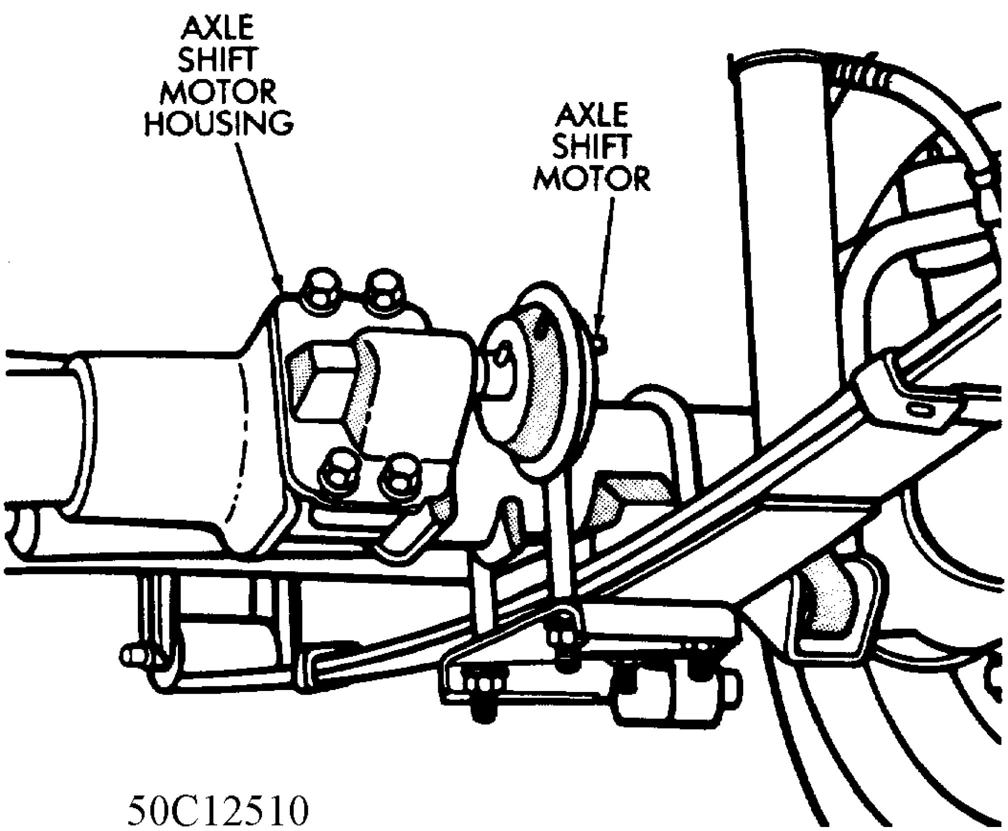


Fig. 3: Axle Vacuum Shift Motor and Housing

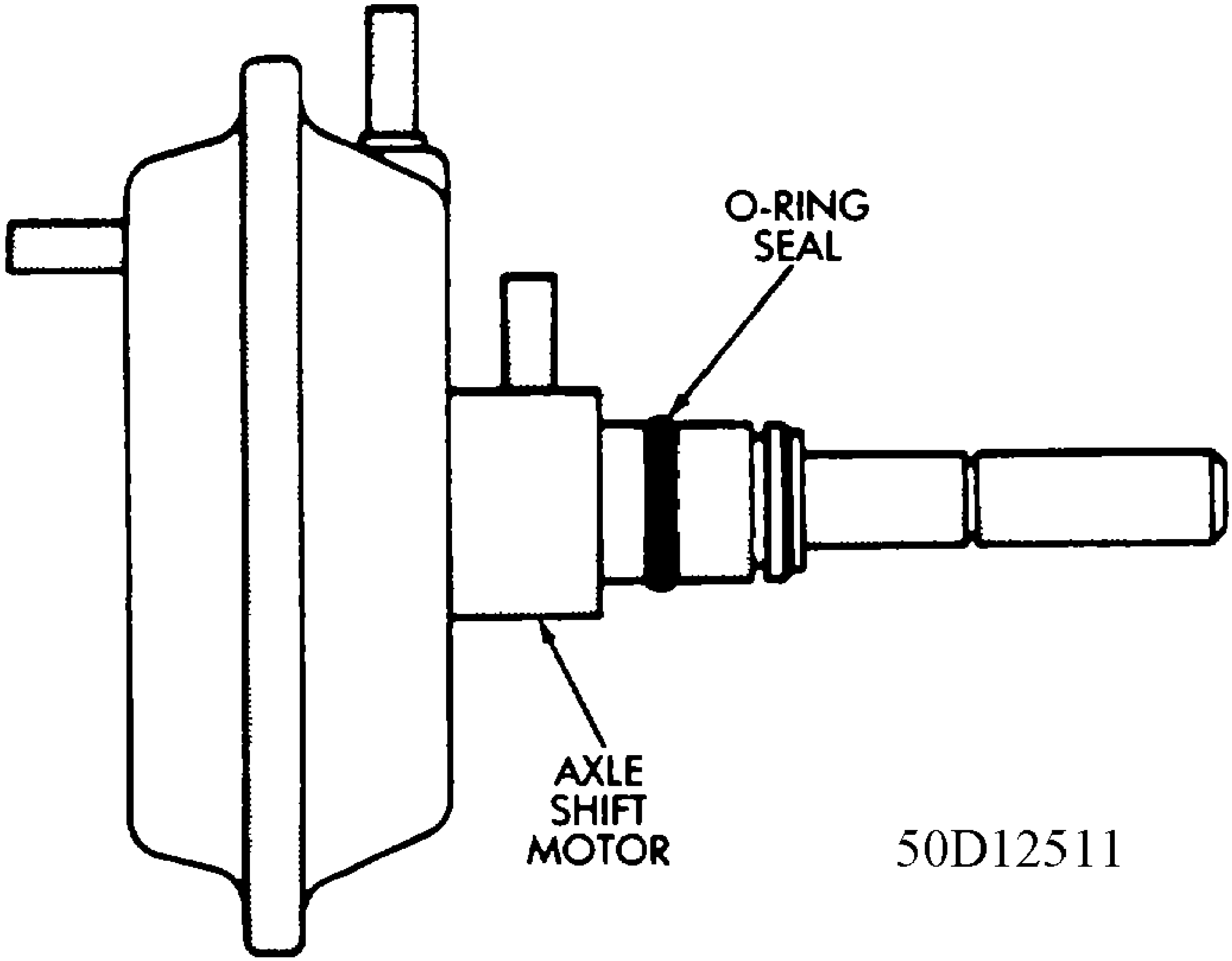


Fig. 4: Axle Vacuum Shift Motor Shaft O-Ring Seal

TRANSFER CASE - OVERHAUL (207/231)

1988 Jeep Cherokee

1983-96 TRANSFER CASES
Chrysler Corp., GM Corp., Jeep - New Process 207 & 231

Dodge; B1500 & Dakota
GMC/Chevrolet; "T" Series (Blazer & Jimmy)
Jeep; Cherokee, Comanche, Grand Cherokee, Wagoneer, Wrangler

IDENTIFICATION

Transfer case can be identified by an I.D. tag, located on rear case. I.D. tag provides model number, serial number and low range ratio. Date of manufacture is the serial number (I.D. number). This information is necessary when ordering parts.

DESCRIPTION

Model 231 transfer case is a part time, chain-driven, 4-position unit with 2-piece aluminum case. Torque input in 4WD high and low range is undifferentiated. 2WD operation is achieved by a vacuum shift motor. Shift motor disconnects right front axle when 2WD is selected. Vacuum shift motor is controlled by a vacuum switch located on front of transfer case and actuated by shift sector.

ADJUSTMENTS

GEARSHIFT LINKAGE

Chrysler Corp.
Shift transfer case to 2H position. Raise and support vehicle. Loosen lock bolt at trunnion. Ensure linkage rod slides freely in trunnion. Verify transfer case range lever is fully engaged in 2H position. Tighten lock bolt at trunnion. Lower vehicle. Check shift linkage operation. Ensure transfer case shifts into and operates properly in all gear ranges.

General Motors
Remove shift lever knob retainer. Remove shift lever knob. Remove floor console. Place shift lever in Neutral. Pry control cable end from shift lever. Loosen control cable lock nut. Check transfer case to ensure it is in Neutral. Ensure shift lever is in Neutral. Turn shift lever end of cable in or out as needed until it is aligned with shift lever. Install control cable on shift lever. Tighten control cable lock nut.

Jeep
Shift transfer case to 4L position. Raise and support vehicle. Loosen lock bolt at trunnion. Ensure linkage rod slides freely in trunnion. Verify transfer case range lever is fully engaged in 4L position. Tighten lock bolt at trunnion. Lower vehicle. Check shift linkage operation. Ensure transfer case shifts into and operates properly in all gear ranges.

TESTING

VACUUM SWITCH

Shift to 2WD position. Locate vacuum switch on front of

transfer case. Apply 15 in. Hg vacuum to "L". See Fig. 1. Vacuum should be present at "M". Connect a vacuum gauge to "N". Shift to 4WD position. Apply vacuum to "L". Vacuum should be present at "N". If switch fails any test, replace switch.

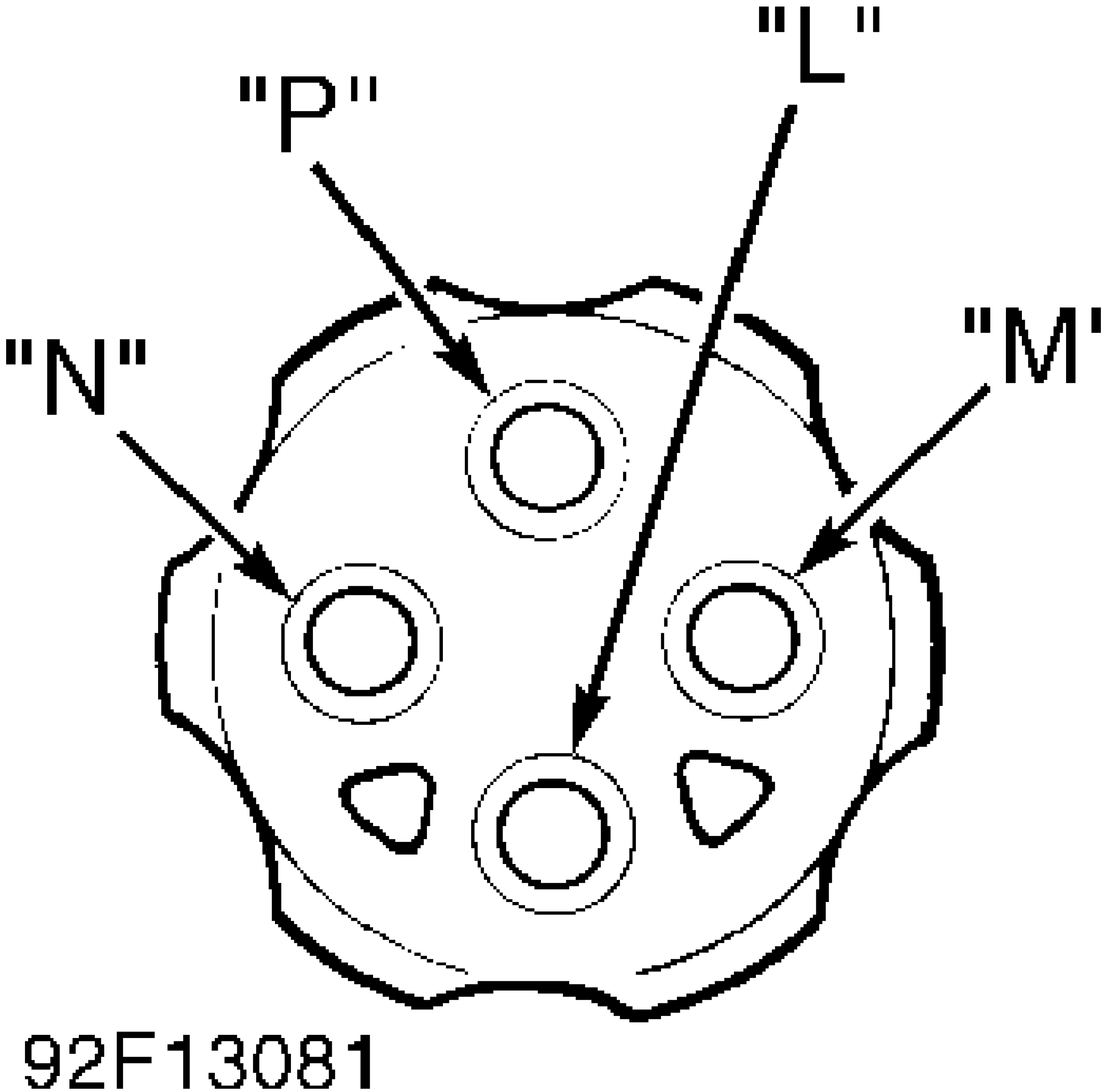


Fig. 1: Testing Vacuum Switch
Courtesy of Chrysler Corp.

TROUBLE SHOOTING

SYMPTOM DIAGNOSIS

Will Not Shift Or Difficult To Shift Into Gear

Vehicle speed too high; slow vehicle to 2-3 MPH to shift. Vehicle operated too long on dry paved surface; stop vehicle and place in Reverse or Neutral to relieve driveline torque. Ensure transfer case external linkage is not binding. Ensure correct fluid is used. Internal parts may be worn or damaged.

Noisy In All Gears

Check fluid level. Ensure correct fluid is used. If fluid is okay, locate possible internal mechanical problem.

Jumps Out Of Gear Or Noisy In 4WD

Transfer case not completely in gear; check shift linkage. Range fork damaged. Shift fork pads are worn or shift fork binding. Low range gear worn.

Fluid Leaking From Vent Or Seals

Transfer case overfilled. Vent plugged. Output shaft seals are damaged or not installed properly.

ON-VEHICLE SERVICE

FRONT OIL SEAL

Removal & Installation

1) Mark front drive shaft and flange for installation alignment reference. Remove front drive shaft. Remove flange. Discard washer and nut. Using a screwdriver, carefully remove oil seal. Ensure seal contact surface is clean.

2) Apply ATF to seal lip and flange seal surface. Install NEW oil seal. Install flange and NEW washer and nut. Tighten nut to specifications. See TORQUE SPECIFICATIONS. Install front drive shaft using alignment marks. Check transfer case fluid.

EXTENSION HOUSING OIL SEAL & BUSHING

Removal & Installation

1) Mark rear drive shaft and flange for installation alignment reference. Remove rear drive shaft. Tap extension housing in a clockwise direction and remove extension housing. DO NOT pry on extension housing. Using a screwdriver, remove oil seal from extension housing.

2) Using bushing driver, replace bushing in extension housing. Install NEW extension housing oil seal. Apply silicone sealant to extension housing mating surface. Install extension housing. To complete installation, reverse removal procedure.

REMOVAL & INSTALLATION

TRANSFER CASE

Removal

1) Shift transfer case into 4H and disconnect battery negative cable. Raise vehicle, remove skid plate and drain fluid.

2) Mark front and rear output shaft yokes to drive shafts for reassembly reference. Support transfer case and remove rear crossmember. Remove drive shafts.

3) Disconnect vehicle speed sensor electrical connector and vacuum (hoses) harness at transfer case. Remove shift lever or linkage rod from case. Remove transfer case attaching bolts. Remove transfer case from vehicle.

Installation

1) Clean all old gasket material from transmission and transfer case mating surfaces. Position NEW gasket on transfer case with orientation tab at upper left bolt hole.

2) Install transfer case, aligning splines of input shaft with transmission. Slide transfer case forward until seated against transmission. Install transfer case attaching bolts and tighten to specification. See TORQUE SPECIFICATIONS. Install rear crossmember.

3) Attach shift lever and connect speed sensor electrical connector and vacuum harness at transfer case. Using reference marks made during removal, reinstall front and rear drive shafts. Refill transfer case. Install skid plate and lower vehicle. Connect negative battery cable. Road test vehicle.

TRANSFER CASE DISASSEMBLY

1) Remove front companion yoke. See Fig. 2 or 3. Discard washer and nut. Shift transfer case to 4L and remove extension housing. Remove rear bearing snap ring. Using 2 screwdrivers under each tab, remove retainer housing. Remove rear case and oil pump as an assembly.

2) Remove oil pump pick-up screen and tube from rear case. Remove oil pump. Remove "O" ring from oil pump and discard. DO NOT separate oil pump halves. Pump must be replaced as an assembly if necessary.

3) Remove mode spring. Using a soft hammer, tap front output shaft upward and remove with drive chain as an assembly. Remove mainshaft, mode fork and shift rail as an assembly. Remove mode fork and shift rail from synchronizer sleeve.

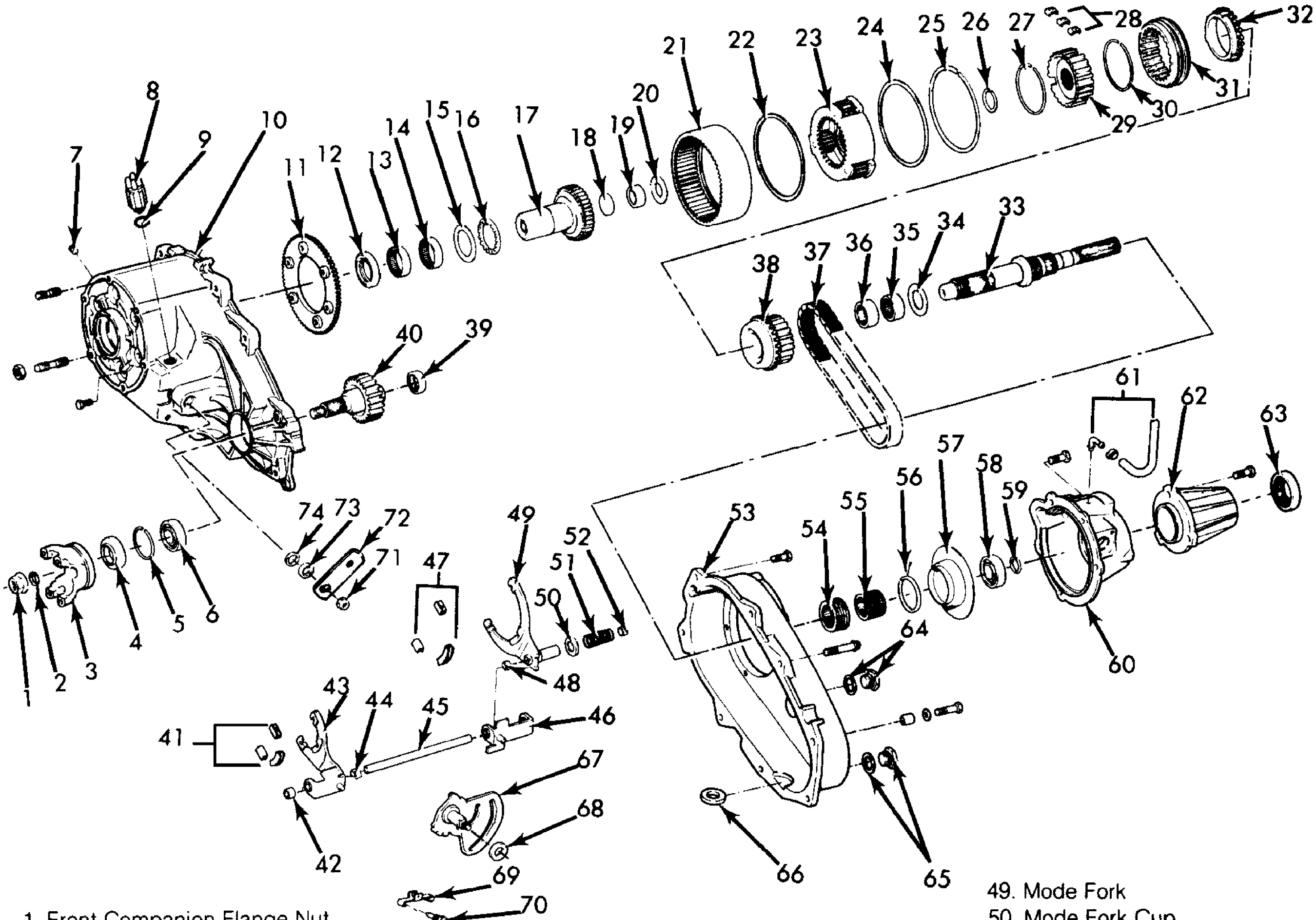
4) Mark synchronizer sleeve position for reassembly reference. Remove synchronizer sleeve from mainshaft. Remove synchronizer hub snap ring. Remove synchronizer hub, stop ring and drive sprocket. Slide range fork pin out of sector.

5) Remove range fork and shift hub as an assembly. Remove range lever from sector shaft. Remove shift sector, bushing and "O" ring. Remove shift detent pin, spring and plug. Remove front bearing retainer. Remove input gear snap ring.

6) Press input and low range gear assembly from input gear bearing. Remove low range gear snap ring. Remove input gear retainer, thrust washers and input gear from low range gear.

7) Remove all oil seals. Remove magnet from front case. Remove front bearing snap ring. Using a plastic hammer, remove front bearing. Press input gear bearing from front case.

8) Using slide hammer and internal puller, remove input gear pilot bearing. Press bearings from drive sprocket. Using internal puller and slide hammer, remove output shaft rear bearing.



1. Front Companion Flange Nut
2. Front Companion Flange Seal
3. Front Companion Flange
4. Front Output Shaft Seal
5. Snap Ring
6. Front Output Shaft Bearing
7. Case Plug
8. Vacuum Switch
9. Gasket
10. Front Case
11. Low Range Lock Plate
12. Input Gear Seal
13. Input Gear Front Bearing
14. Input Gear Rear Bearing
15. Thrust Bearing Washer
16. Input Gear Thrust Bearing
17. Input Gear
18. Input Gear Cup Plug
19. Mainshaft Pilot Bearing
20. Planetary Thrust Washer
21. Annulus Gear
22. Front Thrust Ring
23. Planetary Gear
24. Rear Thrust Ring
25. Planetary Retaining Ring
26. Snap Ring
27. Synchronizer Front Spring
28. Synchronizer Struts
29. Synchronizer Hub
30. Synchronizer Rear Spring
31. Synchronizer Sleeve
32. Synchronizer Stop Ring
33. Mainshaft
34. Thrust Washer
35. Drive Sprocket Rear Bearing
36. Drive Sprocket Front Bearing
37. Drive Chain
38. Drive Sprocket
39. Front Output Shaft Bearing
40. Front Output Shaft
41. Range Fork Pads
42. Range Fork Front Bushing
43. Range Fork
44. Range Fork Rear Bushing
45. Shift Rail
46. Shift Rail Bracket
47. Mode Fork Pads
48. Mode Fork Front Bushing
49. Mode Fork
50. Mode Fork Cup
51. Mode Fork Spring
52. Mode Fork Rear Bushing
53. Rear Case
54. Oil Pump
55. Speedometer Drive Gear
56. Pump Housing Seal
57. Oil Pump Housing
58. Mainshaft Rear Bearing
59. Rear Bearing Snap Ring
60. Rear Retainer
61. Vent Assembly
62. Extension Housing
63. Extension Housing Seal
64. Fill Plug
65. Drain Plug
66. Magnet
67. Shift Sector
68. Spacer
69. Sector Detent Spring
70. Detent Spring Bolt
71. Range Lever Nut
72. Range Lever
73. "O" Ring Retainer
74. "O" Ring

95H29410

Fig. 2: Exploded View Of Transfer Case (Model 207)
Courtesy of Chrysler Corp.

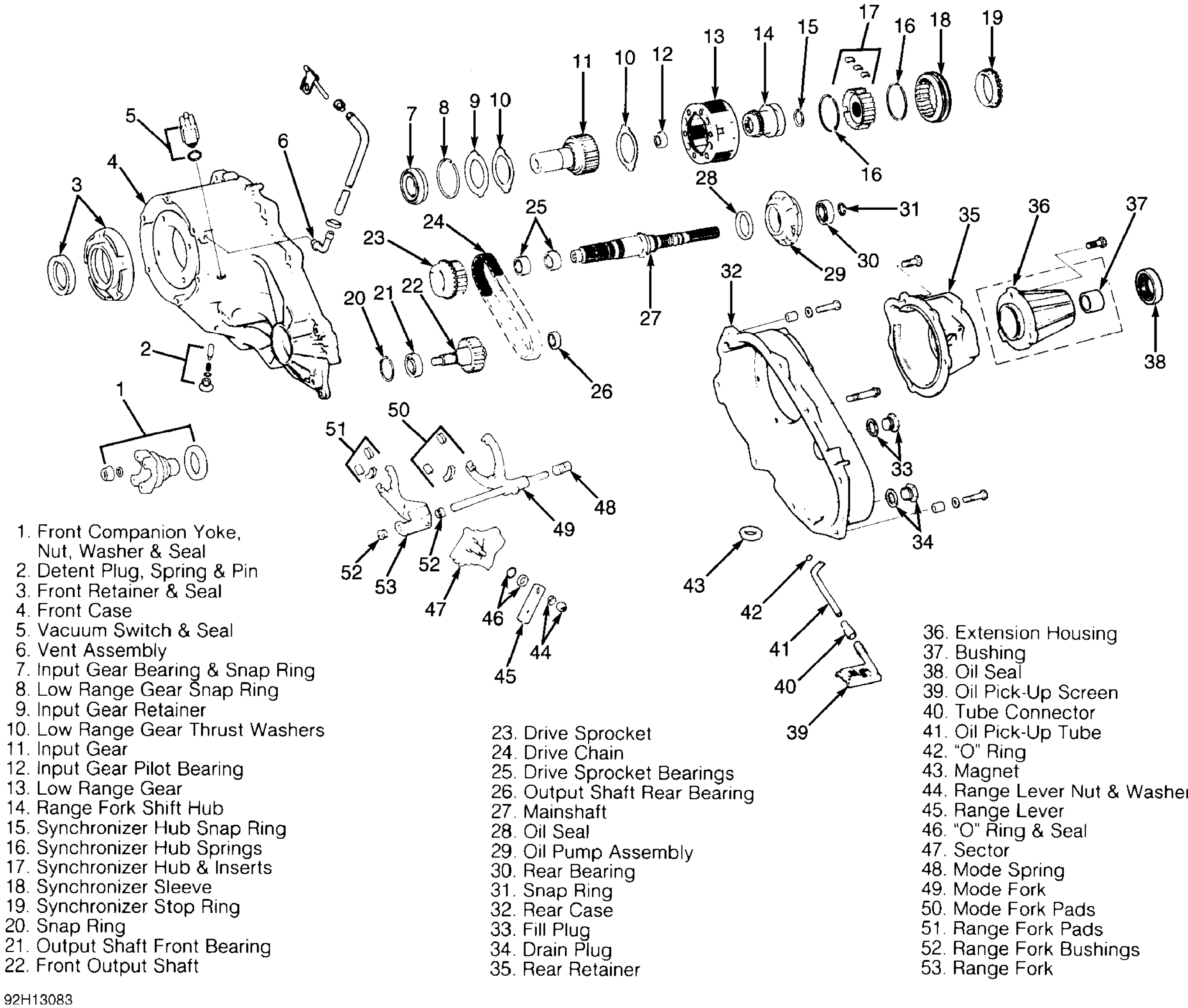


Fig. 3: Exploded View Of Transfer Case (Model 231)
Courtesy of Chrysler Corp.

CLEANING & INSPECTION

Clean all parts with solvent. Dry with compressed air. Replace all oil seals, "O" rings and snap rings. Check all parts for wear or damage. Replace all worn or damaged parts. If low range annulus gear inside front case is damaged or worn, front case and gear must be replaced as an assembly. Replace oil pump as an assembly if any part is damaged or worn.

TRANSFER CASE REASSEMBLY

NOTE: When installing bearings, ensure bearing bores are aligned with oil feed holes.

1) Lubricate all parts with Dexron III before installing.

Install output shaft front bearing with NEW snap ring. Install output shaft oil seal in front case. Install snap ring on NEW input gear bearing. See Fig. 2 or 3.

2) Press input gear bearing so snap ring is seated against case. Using press, install NEW input gear pilot bearing. Assemble low range gear, input gear, thrust washers and retainer.

3) Install snap ring. Ensure snap ring is seated in low range gear groove. Start input gear shaft into bearing in front case. Press input shaft gear into bearing.

CAUTION: DO NOT press against end surfaces of gear. Failure to use proper size tool could lead to gear case or thrust washer damage.

4) Install input gear snap ring. Install oil seal in front bearing retainer. Apply a 1/8" bead of silicone sealant to retainer mating surface. Align oil channel in retainer with oil feed hole in case. Install retainer on case. Tighten bolts to specification.

5) Install sector shaft "O" ring and bushing. Install range sector in case. Install range lever and nut. Install detent, detent spring and plug. Tighten to specification. See TORQUE SPECIFICATIONS. Install NEW pads and fork rail bushings on range fork. Install range fork and shift hub.

6) Ensure range fork pin is engaged with range sector slot. Press front bearing in drive sprocket until bearing is flush with bore edge. Install rear bearing until bearing is 3/16" below bore edge. See Fig. 4.

7) Install inserts and spring in synchronizer hub. Install sprocket on mainshaft. Install synchronizer stop ring on mainshaft. Ensure stop ring is seated. Install synchronizer hub on mainshaft. Align and seat hub inserts on stop ring lugs. Install synchronizer hub snap ring.

8) Install synchronizer sleeve on hub. Ensure sleeve is positioned so beveled spline ends are facing stop ring. Ensure sleeve tooth is aligned (centered) over each synchronizer strut. Gear clash will occur if strut and sleeve teeth are misaligned. Install NEW pads on mode fork. Engage mode fork in synchronizer sleeve. Install mainshaft and fork assembly in case. Ensure mode fork shift rail is seated in both range fork bushings.

9) Install output shaft and drive chain assembly. Install mode spring on shift rail. Using bearing driver, install output shaft rear bearing. Lubricate bearing after installation. Install seal in oil pump feed housing. Install oil pump in housing. Tighten to specification.

10) Install oil pick-up tube "O" ring in oil pump. Prime oil pump by pouring ATF into pump through pick-up tube opening. Install oil pump and pick-up tube in case. Ensure oil screen is properly positioned. See Fig. 5. Install magnet in front case. Apply 1/8" bead of silicone sealer to front case. Install rear case. Tighten to specification. See TORQUE SPECIFICATIONS. Ensure mainshaft splines are engaged with oil pump inner gear and a washer is used on bolts at dowel locations.

11) Install rear bearings in retainer. Apply 1/8" bead of silicone sealer and install retainer to case. Install rear retainer snap ring. Install extension housing. Install front companion yoke. Install NEW gasket on vacuum switch. Install vacuum switch in case. Fill transfer case with Dexron III.

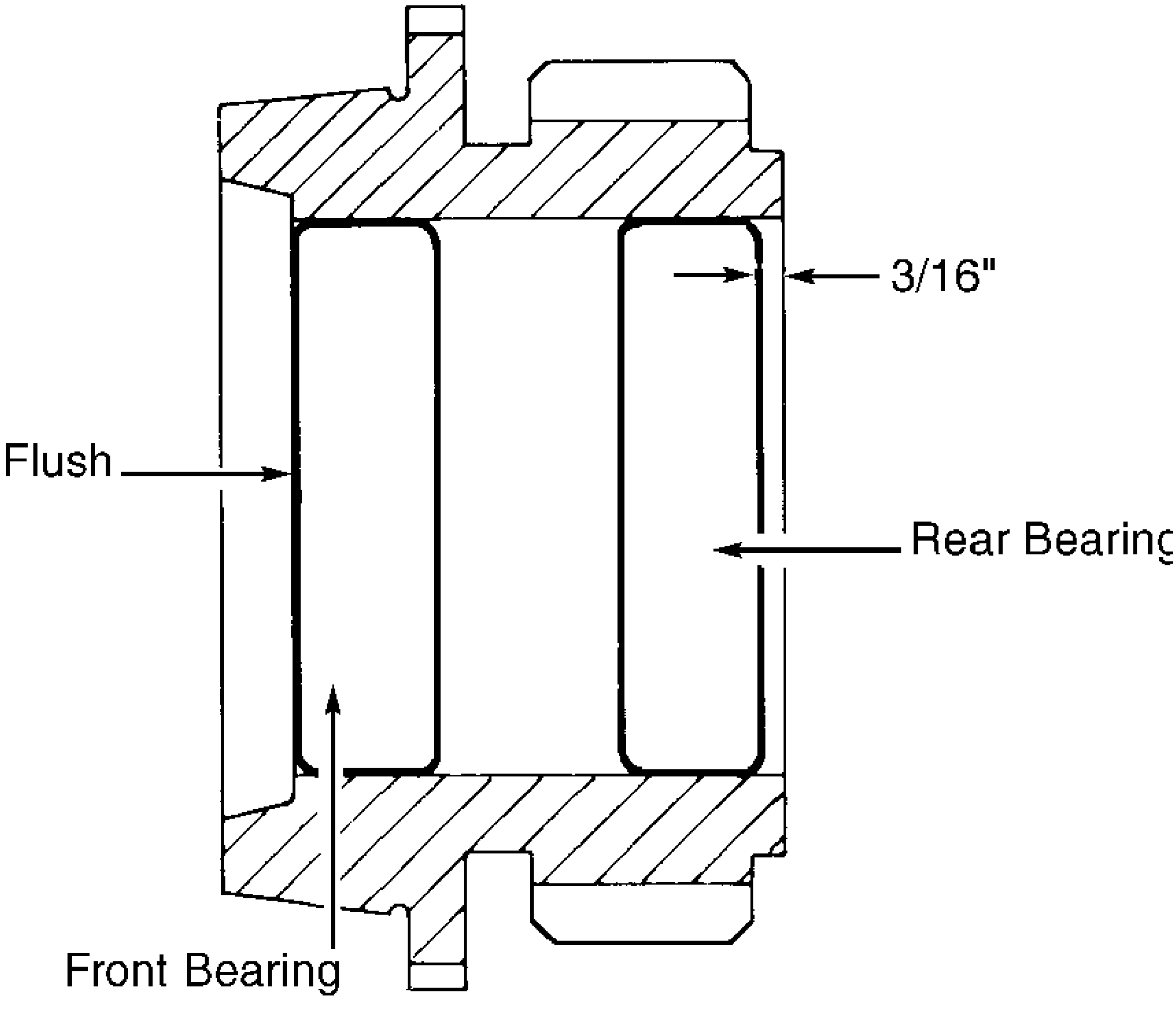


Fig. 4: Installing Drive Sprocket Bearings
Courtesy of Chrysler Corp.

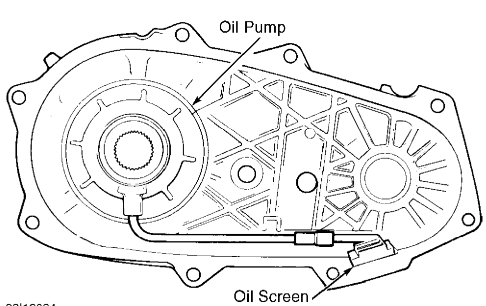


Fig. 5: Identifying Oil Pump Screen Position
Courtesy of Chrysler Corp.

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS TABLE

Application	Ft. Lbs. (N.m)
Companion Flange Nut	
Chrysler Corp.	130-200 (176-271)
General Motors	80 (108)
Jeep	110 (149)
Detent Plug	
General Motors	11 (15)
Chrysler Corp. & Jeep	15 (20)
Drain & Fill Plug	30-40 (41-54)
Extension Housing Bolt	20-25 (27-34)
Front Bearing Retainer Bolt	
Chrysler Corp. & Jeep	16 (22)
General Motors	14 (19)
Front Case-to-Rear Case Bolt	
Chrysler Corp.	
Flange Head Bolt	35-45 (47-61)
All Other Bolts	20-25 (27-34)
General Motors	23 (31)
Jeep	20-25 (27-34)
Range Lever Nut	15-20 (20-27)
Rear Bearing Retainer Bolt	20-25 (27-34)
Rear Crossmember	30 (41)
Shift Lever Lock Bolt	10 (14)
Speed Sensor Bolt	23 (31)
Transfer Case-to-Transmission Nut	26 (35)
Vacuum Switch	
Chrysler Corp.	15-25 (20-34)
General Motors	17 (23)
Jeep	20-25 (27-34)
	INCH Lbs.
Control Cable Lock Nut	18 (2)

VACUUM DIAGRAMS

For vacuum diagrams, refer to appropriate VACUUM DIAGRAMS article in the ENGINE PERFORMANCE section.

TRANSFER CASE - NP/NV 242

1988 Jeep Cherokee

1987-96 TRANSFER CASES
Jeep - New Venture 242

Cherokee, Comanche, Wagoneer, Grand Wagoneer

IDENTIFICATION

Transfer case can be identified by an I.D. tag, located on rear case. I.D. tag provides model number, serial number and low range ratio. Date of manufacture is the serial number (I.D. number). This information is necessary when ordering parts.

DESCRIPTION

Model 242 transfer case is a chain-driven, 2-piece aluminum case, with full time operation. Torque input in 4WD high and low range is undifferentiated.

ADJUSTMENTS

GEARSHIFT LINKAGE

Remove shift boot and shift to 4L position. Loosen trunnion nut. Adjust trunnion and shift rod until rod fits freely. Tighten trunnion nut and remove shim.

TROUBLE SHOOTING

SYMPTOM DIAGNOSIS

Will Not Shift Or Difficult To Shift Into Gear
Check fluid level. Check linkage adjustment. Ensure transfer case external linkage is not binding. Internal parts may be worn or damaged.

Noisy In All Gears
Check fluid level. Ensure correct fluid is used. If fluid is okay, locate noise and check for possible internal mechanical problem.

Jumps Out Of Gear Or Noisy In 4WD
Transfer case not completely in gear; check shift linkage. Range fork damaged. Inserts are worn. Shift fork binding on shift rail. Low range gear worn or damaged.

Fluid Leaking From Vent Or Seals
Transfer case overfilled. Vent plugged. Output shaft seals are damaged or not installed properly.

Transfer Case Will Not Shift Through High Lock Range
Incomplete shift due to driveline torque load; momentarily release accelerator pedal to complete shift. Check tire pressure and tire wear. Vehicle overloaded; remove load and check shifting.

ON-VEHICLE SERVICE

FRONT OIL SEAL

Removal & Installation

1) Mark front propeller shaft and flange for alignment purposes. Remove front propeller shaft. Remove flange. Discard washer and nut. Using a screwdriver, carefully remove oil seal. Ensure seal contact surface is clean.

2) Apply ATF to seal lip and yoke seal surface. Install oil seal and flange with new washer and nut. Install front propeller shaft using alignment marks. Check transfer case fluid.

EXTENSION HOUSING OIL SEAL & BUSHING

NOTE: When replacing oil seal, DO NOT remove extension housing.

Removal & Installation

1) Mark rear propeller shaft and flange for installation purposes. Remove rear propeller shaft. Remove bolts and tap extension housing in a clockwise direction and remove extension housing. DO NOT pry on extension housing. Using a screwdriver, remove oil seal from extension housing.

2) Using bushing driver, replace bushing in extension housing. Install new extension housing oil seal. Apply silicone sealant to extension housing mating surface. Install extension housing. Reverse removal procedure to complete installation.

REMOVAL & INSTALLATION

TRANSFER CASE

Removal & Installation

1) Shift transfer case into Neutral position and drain fluid. Mark front and rear drive shaft for installation purposes. Remove front and rear drive shafts. Disconnect vacuum lines and speedometer cable. Remove rear crossmember.

2) Disconnect shift linkage. Support transfer case with a jack. Separate transfer case from transmission. Remove transfer case. To install, reverse removal procedure. Tighten bolts to specification. See TORQUE SPECIFICATIONS. Adjust shift linkage, if necessary.

TRANSFER CASE DISASSEMBLY

1) Remove drain and fill plugs. See Fig. 1. Remove front companion flange, washer and seal. Place transfer case in 4L position. Remove extension housing. See EXTENSION HOUSING OIL SEAL & BUSHING under ON-VEHICLE SERVICE. Remove rear bearing snap ring. Remove rear bearing retainer. Separate rear case from front case using prybars or screwdriver. DO NOT damage mating surfaces.

NOTE: DO NOT disassemble oil pump, replace as unit only.

2) Remove oil pump, pick-up tube and screen from rear case. Remove pick-up tube "O" ring from oil pump. Remove magnet from front case. Remove drive sprocket snap ring. Remove drive sprocket and drive chain.

3) Remove front output shaft. Remove shift lever from sector shaft. Remove shift detent plug, spring and plunger. Remove plug from low range fork lock pin access hole. Move shift sector until lock pin is aligned with hole. Remove lock pin with No. 1 screw extractor.

4) Remove shift rail from fork assembly. Remove mode fork and mainshaft as an assembly. Record mode sleeve position. Remove mode shift sleeve and mode fork assembly. Remove sleeve from fork. Remove

intermediate clutch shaft snap ring from mainshaft.

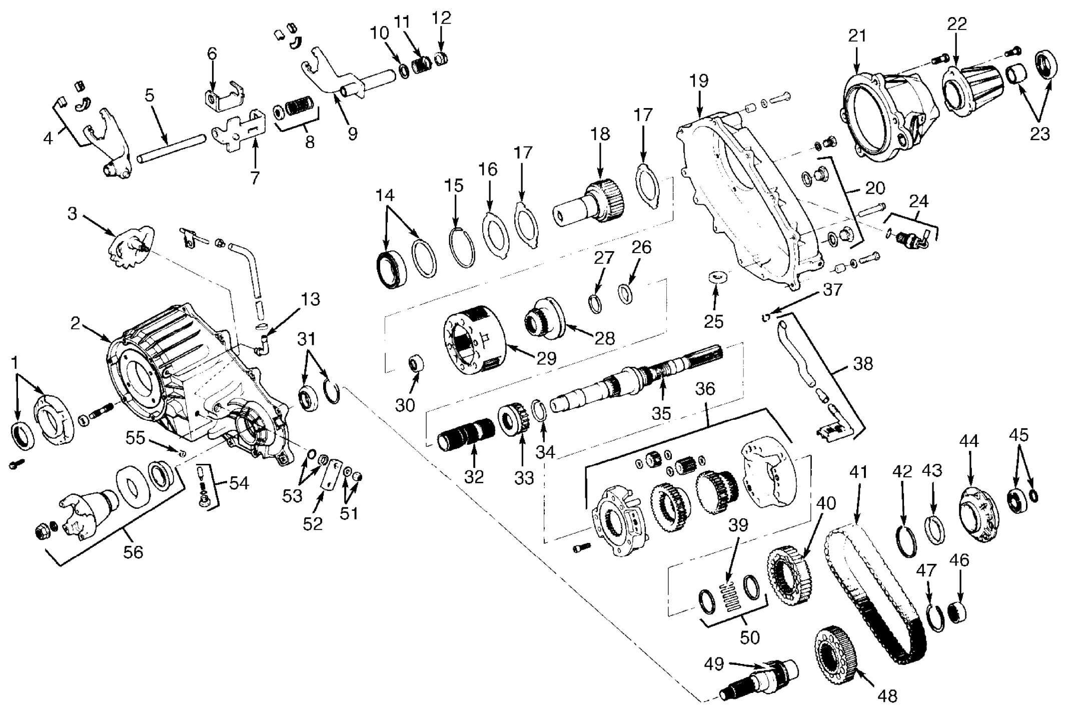
5) Remove clutch shaft thrust ring. Remove intermediate clutch shaft. Remove differential retaining snap ring. Remove differential assembly. Remove differential needle bearings and thrust washers from mainshaft. Remove low range fork and hub.

6) Remove shift sector. Remove shift sector bushing and "O" ring. Remove front bearing retainer. Remove input gear snap ring. Using a press, remove input and low range gear assembly from input gear bearing. Remove low range gear snap ring.

7) Remove input gear retainer, thrust washers and input gear. Mark differential halves for reassembly purposes. Separate differential halves. Remove planetary gear and thrust washers.

8) Record mainshaft gear and sprocket gear position. Remove gears. Remove front output shaft front bearing oil seal, snap ring and front bearing. Using a press, remove input gear bearing.

9) Using slide hammer and internal puller, remove input gear pilot bearing. Using slide hammer and internal puller, remove front output shaft rear bearing.



1. Front Bearing Retainer & Seal
2. Front Case
3. Shift Sector
4. Low Range Fork & Inserts
5. Shift Rail
6. Shift Bracket
7. Slider Bracket
8. Bushing & Spring
9. Mode Fork & Inserts
10. Bushing
11. Fork Spring
12. Bushing
13. Vent Tube
14. Input Gear Bearing & Snap Ring
15. Low Range Gear Snap Ring
16. Low Range Gear Retainer
17. Low Range Gear Thrust Washer
18. Input Gear
19. Rear Case
20. Drain & Fill Plugs
21. Rear Bearing Retainer
22. Extension Housing
23. Bushing & Oil Seal
24. Vacuum Switch (If Equipped)
25. Magnet
26. Thrust Ring
27. Snap Ring
28. Shift Sleeve
29. Low Range Gear
30. Pilot Bushing
31. Front Output Shaft Front Bearing & Snap Ring
32. Intermediate Clutch Shaft
33. Shift Sleeve
34. Snap Ring
35. Mainshaft
36. Differential Assembly
37. Oil Pick-Up Tube "O" Ring
38. Oil Pick-Up Tube & Screen
39. Mainshaft Bearing Rollers
40. Drive Sprocket
41. Drive Chain
42. Snap Ring
43. Oil Pump Seal
44. Oil Pump
45. Rear Bearing & Snap Ring
46. Front Output Shaft Rear Bearing
47. Snap Ring
48. Driven Sprocket
49. Front Output Shaft
50. Mainshaft Bearing Spacers
51. Shift Lever Washer & Nut
52. Shift Lever
53. Sector "O" Ring & Seal
54. Detent Pin, Spring & Plug
55. Seal Plug
56. Companion Flange, Nut, Seal, Washer & Oil Slinger

92A13086

Fig. 1: Exploded View Of Model 242 Transfer Case
Courtesy of Chrysler Motors.

CLEANING & INSPECTION

1) Clean all parts with solvent. Dry with compressed air. Replace all oil seals, "O" rings and snap rings. Check all parts for wear or damage. Replace all worn or damaged parts. Apply Dexron II to all parts before installing.

2) Inspect low range annulus gear inside front case. If gear is worn or damaged, replace case and gear as an assembly. Replace oil pump as an assembly if any part is damaged or worn.

NOTE: When installing bearings, ensure bearing bores are aligned with oil feed holes.

TRANSFER CASE REASSEMBLY

1) Install front output shaft front bearing, snap ring and oil seal. Install snap ring on input gear bearing. Using a wooden block and press, install input gear until snap ring is against case.

2) Install input gear pilot bearing. Assemble low range gear, thrust washers, input gear and retainer. Install low range gear snap ring. Ensure snap ring is seated properly in groove.

3) Start input gear shaft through the bearing in front case. Using a press, install input gear shaft through bearing. Ensure adapter is positioned properly before pressing shaft.

NOTE: Ensure proper size tool is used to press input gear shaft; wrong size tool can damage case and thrust washers and will move pilot bearing too far into gear bore.

4) Install input gear snap ring. Install front bearing retainer oil seal. Apply 1/8" bead of silicone sealant to front bearing retainer mating surface. Install front bearing retainer on front case. Install sector shaft "O" ring and bushing. Install shift sector.

5) Install detent pin, spring and plug. Install low range fork pads. Assemble low range fork and hub. Ensure low range fork pin is engaged in shift sector slot. Install differential sprocket gear in lower differential case. Install planet gears and new thrust washers on lower case pins.

6) Ensure thrust washers are positioned on top and bottom of each planet gear. Install mainshaft gear. Align marks on upper and lower differential case. Install bolts and tighten to specifications. See TORQUE SPECIFICATIONS. Install needle bearing spacer on mainshaft.

7) Using petroleum jelly to hold needles, install bearings on mainshaft. Install other spacer. Install differential assembly. Ensure all needle bearings are in place. Install differential snap ring. Install intermediate clutch shaft. Install thrust washer and snap ring. Install mode shift sleeve in mode fork.

8) Install mode fork assembly on mainshaft. Ensure mode shift sleeve splines engage with differential splines. Install mode fork and mainshaft assembly in case. If necessary, rotate mainshaft slightly to engage mainshaft with low range components.

9) Install mode fork pin into shift sector slot. Install shift rail. Ensure shift rail is seated in shift forks. Rotate shift sector so lock pin can be installed. Install lock pin so tapered end is in fork and rail. Install plug. Install shift lever and nut on shift sector shaft.

10) Install detent plunger, spring and plug. Install front output shaft. Install drive chain and sprocket. Install drive sprocket snap ring. Install front output shaft rear bearing.

11) Install oil seal in oil pump housing. Assemble oil pump gears in housing. Ensure oil feed hole is aligned with hole in housing. Install oil pump screws. Tighten to specification. Install

"O" ring in oil pump. Install oil pick-up tube and screen. Ensure screen is properly positioned. See Fig. 2.

12) Install magnet in front case. Apply 1/8" bead of silicone sealant to front case mating surface. Assemble case halves together. Tighten to specification. Ensure mainshaft splines are engaged with oil pump inner gear and a washer is used on bolts at dowel locations.

13) Install rear retainer bearing in retainer. Apply 1/8" bead of silicone sealer and install retainer to case. Install rear bearing snap ring. Install extension housing. Install front companion flange. Install vacuum switch and drain plug. Fill transfer case with Dexron II.

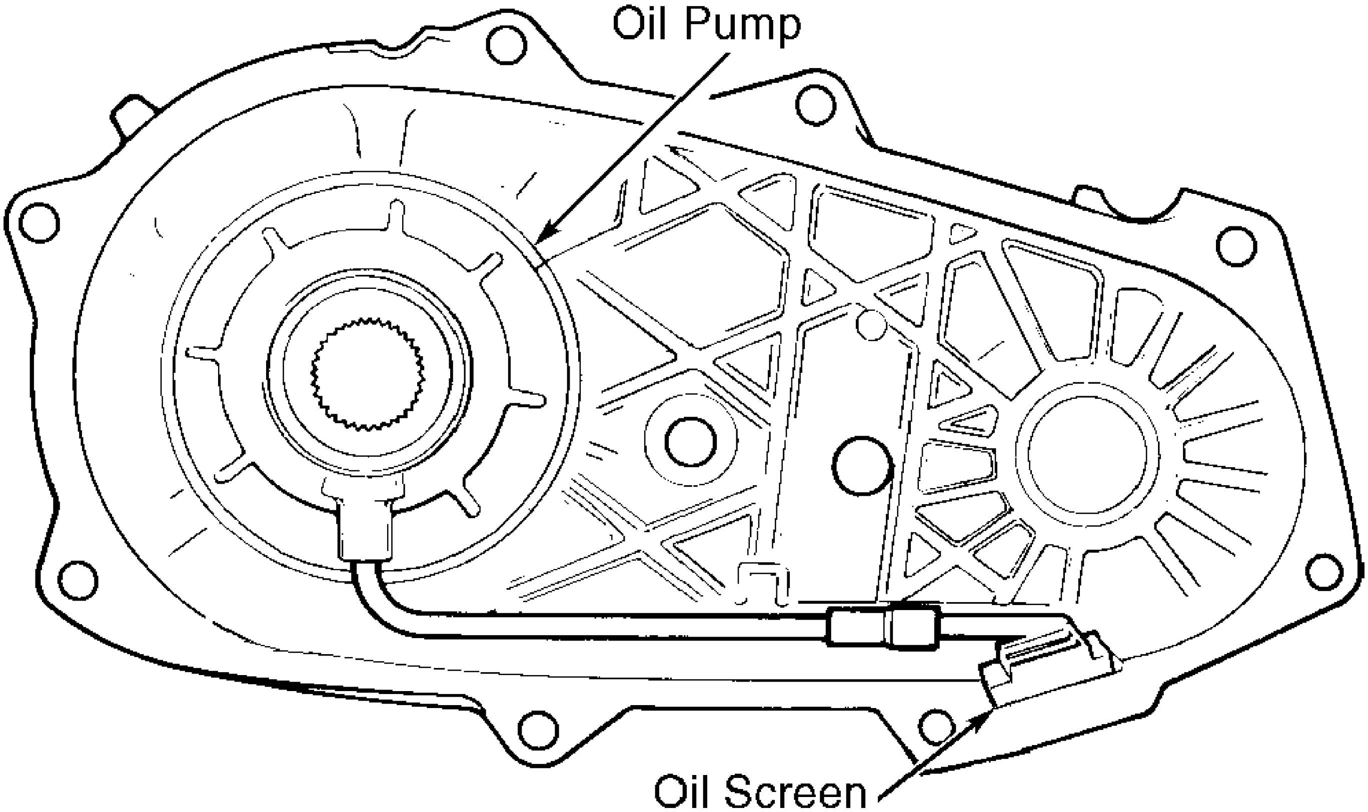


Fig. 2: Identifying Oil Pump Screen Position
Courtesy of Chrysler Motors.

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS TABLE

Application	Ft. Lbs. (N.m)
Companion Flange Nut	90-130 (122-176)
Detent Plug	14 (19)
Drain & Fill Plug	27 (37)
Extension Housing Bolt	26 (35)
Front Bearing Retainer Bolt	12 (16)
Front Case-to-Rear Case Bolt	26-34 (35-46)
Shift Fork Set Screw	15 (20)
Transfer Case-to-Transmission	26 (35)

TRANSMISSION REMOVAL & INSTALLATION - A/T

1988 Jeep Cherokee

1988 Automatic Transmission Removal
JEEP

TRANSMISSION

ALL MODELS

Removal

1) Disconnect fan shroud and transmission fill tube upper bracket. Raise vehicle. Remove converter inspection cover and fill tube. Remove starter.

2) Mark drive shafts for reassembly. Disconnect shafts at transfer case and wire to frame rails. DO NOT allow shafts to hang free as damage to universal joints may result. On V8 models, disconnect exhaust pipes from exhaust manifolds. Drain transfer case lubricant. Disconnect speedometer cable from transmission.

3) Disconnect all shift and throttle linkages and wiring from transmission and transfer case. Mark converter drive plate and converter for reassembly and remove torque converter-to-drive plate bolts. Rotate crankshaft to gain access to bolts.

4) Support transmission/transfer case assembly with jack and secure with chain. Remove bolts and rear transmission crossmember. Lower transmission enough to disconnect cooler lines at transmission. Remove transmission-to-engine retaining bolts and slowly slide transmission assembly away from engine.

5) Hold converter in position while lowering transmission assembly from vehicle. Separate transmission from transfer case.

Installation

To install, reverse removal procedures. DO NOT tighten exhaust pipe attaching bolts until crossmember has been installed and transmission jack has been removed. Make sure all index marks made at removal are aligned. Tighten all bolts to specification and fill transmission and transfer case with fluid.

TORQUE SPECIFICATIONS

TIGHTENING SPECIFICATIONS

Application	Ft. Lbs. (N.m)
Cooler Line Nuts	25 (34)
Torque Converter-to-Drive Plate Bolts	22 (30)
Transfer Case-to-Transmission Bolts	40 (54)
Transmission-to-Engine Bolts	30 (41)

TRANSMISSION REMOVAL & INSTALLATION - M/T

1988 Jeep Cherokee

1988 MANUAL TRANSMISSION REMOVAL
Jeep

Cherokee, Comanche, Grand Wagoneer, Pickup, Wagoneer, Wrangler

REMOVAL & INSTALLATION

TRANSMISSION

Removal

1) Remove screws attaching shift lever boot to floorpan. Slide boot over lever. On models with T-176 transmission, press and turn shift lever retainer counterclockwise to release lever.

2) Remove lever, boot, spring and seat as an assembly. On all models, raise vehicle and support with safety stands. Disconnect rear drive shaft from transfer case and wire out of way.

3) DO NOT allow shaft to hang free, as damage to universal joint may result. Disconnect front parking brake cable at equalizer. Remove rear cable clip from crossmember.

4) Place a jack under clutch housing to support engine. Remove rear crossmember from frame. Disconnect speedometer cable, back-up light switch wire and 4WD indicator switch wire.

5) Disconnect transfer case vent hose. Disconnect front drive shaft and wire out of way. On Wrangler, remove transfer case shift lever by removing shifter shaft retaining nut.

6) Remove cotter pins retaining shift control link pins in shift rods and remove pins. Remove shifter shaft and disengage shift lever from shift control links. Move lever out of the way.

NOTE: On some models, shifter shaft must be unthreaded from shift lever in order to be removed. On other models, shaft can be removed by sliding it out of lever.

7) Remove cotter pin and washers connecting link to shift lever. Separate link from lever. Support transmission and transfer case with jack.

8) Remove bolts securing transmission to clutch housing and remove transmission and transfer case. Separate transfer case and transmission.

Installation

1) Install pilot bushing lubricating wick and align throw out bearing with splines in driven plate hub. Shift transmission into gear using shift lever or a long screwdriver. This prevents clutch shaft from rotating during installation and makes clutch shaft-to-driven plate spline alignment easier.

2) Mount transmission on transmission jack. Raise transmission and align transmission clutch shaft with splines in driven plate hub.

3) When transmission is seated on clutch housing, install and tighten transmission-to-clutch housing bolts. Apply Permatex No. 3 sealer to both sides of replacement transmission output shaft and transfer case input shaft splines.

4) To install transmission, reverse removal procedure. Adjust clutch and shift linkage.

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS TABLE

Application	Ft. Lbs. (N.m)
Transmission-to-Clutch Housing	55 (75)
Transmission Cover Bolts	55-65 (75-88)
Housing-to-Transmission Case	40-45 (54-61)
Crossmember Attaching Bolts	34-40 (46-54)
Filler Plug	13-15 (18-20)

TRANSMISSION SERVICING - A/T

1988 Jeep Cherokee

1988 Automatic Transmission Servicing
JEEP

LUBRICATION

SERVICE INTERVALS

Transmission

Check fluid level and condition of fluid at each engine oil change. Under normal, light duty operating conditions, change fluid, replace filter and adjust bands every 2 yrs. or 25,000 miles. Under heavy duty service, change fluid, replace filter and adjust bands every 12 months or 12,500 miles.

Transfer Case

Check transfer case fluid every 12,000 miles and replace fluid every 30,000 miles.

CHECKING FLUID LEVEL

Transmission

Park vehicle on a level surface and apply parking brake. With engine idling at normal operating temperature, move transmission selector lever through all gears, ending in "N" ("P" for AW-4 transmission). Check fluid level. Fluid level should be between "FULL" and "ADD ONE PINT" mark on dipstick. Add fluid as needed. DO NOT overfill.

Transfer Case

Remove fill plug. Check oil level. If level is not up to fill plug opening, add lubricant until it is.

RECOMMENDED FLUID

Both transmissions and transfer cases use DEXRON-II ATF.

FLUID CAPACITY

NOTE: Transmission and converter capacities are approximate. Fluid level should always be determined by reading on dipstick, rather than amount of fluid added.

TRANSMISSION REFILL CAPACITIES

Application	Quantity
All Models	
Including Converter	8.5 qts. (8.0L)
Without Converter	4.3 qts. (4.0L)

TRANSFER CASE REFILL CAPACITIES

Application	Capacity
Model 207	4.5 pts. (2.1L)
Model 208	6.0 pts. (2.8L)

Model 228	7.0 pts. (3.3L)
Model 229	6.0 pts. (3.8L)

DRAINING & REFILLING

Transmission

1) Loosen oil pan bolts, tap pan to break it loose and allow fluid to drain. Remove pan. Install new filter on bottom of valve body and tighten retaining screws. Install new "O" ring on fluid pick-up pipe (if needed). Clean oil pan and install with new gasket.

2) Refill transmission with fluid. Start engine and allow to run at curb idle for a few minutes. With vehicle on level surface, engine idling and parking brake applied, move shift selector lever through all gear ranges, ending in "N" ("P" for AW-4 transmission). Add fluid up to "ADD ONE PINT" mark on dipstick.

3) Recheck fluid level when transmission reaches normal operating temperature. Fluid should be between "ADD ONE PINT" and "FULL" marks on dipstick. Transmission must NOT be overfilled.

Transfer Case

Remove drain plug from transfer case. Remove fill plug for easier draining. With fluid fully drained, reinstall drain plug. Fill transfer case to fill plug opening with Dexron II.

ADJUSTMENT

NOTE: Bands on the AW-4 (4-speed overdrive) transmission are not adjustable. If slippage occurs, bands must be replaced.

KICKDOWN (FRONT) BAND

1) Locate kickdown band adjusting screw on left side of case (near throttle lever shaft). Loosen adjusting screw lock nut and back off approximately 5 turns. Ensure adjusting screw turns freely in case.

2) Using Adapter (J-24063) and 5/16" square socket, tighten screw to 36 INCH lbs. (4 N.m). If adapter is not used, tighten screw to 72 INCH lbs. (8 N.m). Back off adjusting screw. See KICKDOWN (FRONT) BAND ADJUSTMENT table. Hold adjusting screw in position and tighten lock nut to 35 ft. lbs. (48 N.m).

KICKDOWN (FRONT) BAND ADJUSTMENT

Application	(1) Back Off Screw
All Models	2 1/2 Turns

(1) - Tighten screw to 72 INCH lbs. (8 N.m) and back off indicated number of turns.

LOW-REVERSE (REAR) BAND

1) Raise vehicle, drain transmission fluid and remove oil pan. Locate adjusting screw on rear servo lever. Loosen adjusting screw lock nut and back off about 5 turns.

2) Tighten screw to 41 INCH lbs. (4.6 N.m) and back off screw at indicated number of turns. See LOW-REVERSE (REAR) BAND ADJUSTMENT table. Hold adjusting screw in position and tighten lock nut to 35 ft. lbs. (48 N.m). Install oil pan and fill transmission

with fluid.

LOW-REVERSE (REAR) BAND ADJUSTMENT

Application	Tighten Screw to INCH Lbs. (N.m)	Back Off Screw
Model 727	41 (4.6 N.m.)	2 Turns
Model 904	41 (4.6 N.m.)	7 Turns
Model 999	41 (4.6 N.m.)	4 Turns

TRANSMISSION THROTTLE CABLE/LINKAGE

NOTE: A special Idle Speed Actuator (ISA) Exerciser Box Tool is required to initially set ISA motor and adjust transmission throttle linkage on vehicles with transmission model 999 with 4-cylinder engines.

727 Transmission with 6-Cylinder Engines

1) Disconnect throttle control rod spring. Use spring to hold transmission throttle control lever forward, against stop. Block choke open and release fast idle cam.

2) On carburetors equipped with throttle operated solenoid valve, turn key to "ON" position to energize solenoid. Open throttle halfway to allow solenoid to lock. Return throttle to idle position.

3) Loosen retaining bolt on throttle control adjusting link. DO NOT remove spring clip or nylon washer. Pull on end of link to eliminate lash. Tighten link retaining bolt. Reconnect throttle control rod spring.

727 Transmission with V8 engines

1) Disconnect throttle control rod spring. Use spring to hold transmission throttle valve control lever against forward stop. Block choke open and release fast idle cam.

2) On carburetors equipped with throttle operated solenoid valve, turn key to "ON" position to energize solenoid. Open throttle halfway to allow solenoid to lock. Return throttle to idle position.

3) Loosen retaining bolt on throttle control rod adjusting link. Remove spring clip and slide nylon washer to rear of link. Push on end of link to eliminate lash and tighten retaining bolt. Install nylon washer and spring clip. Reconnect throttle control rod spring.

904 Transmission with 6-Cylinder Engines

1) Remove air cleaner. Hold throttle control lever rearward against its stop. Block choke plate open and set carburetor linkage completely off fast idle cam.

2) Unlock throttle control cable by lifting "T" shaped adjuster clamp with small screwdriver. Move cable outer sheath forward to remove any cable load on throttle cable bellcrank.

3) Adjust cable by moving cable and sheath rearward until there is no lash between cable and throttle linkage. Lock cable by pressing "T" shaped clamp downward until clamp snaps into place. Install and reconnect any parts removed and/or disconnected.

999 Transmission with 4-Cylinder Engines

1) Raise vehicle. Using a spring, hook one end on throttle control lever and other end on torque converter housing. Lower vehicle.

2) Disconnect the ISA motor and connect Exerciser Box to ISA. Adjustment light should turn off and ready light should turn on. Press retrack button. Wait until ISA adjusts, ready light goes off and adjust light goes on.

3) Loosen bolt on throttle control link. Pull on link end to eliminate lash. Tighten adjusting bolt. Press extend button on Exerciser Box. When ISA retracts, release button and disconnect Exerciser Box. Connect ISA wiring and remove spring from throttle control lever. Install and reconnect any parts removed and/or disconnected.

999 Transmission with 6-Cylinder Engines

1) Disconnect throttle control rod spring. Use spring to hold adjusting link in forward position, against nylon washer. Block choke open and release fast idle cam.

2) Raise vehicle. Loosen both retaining bolts on adjusting link clamp. DO NOT remove spring clip or nylon washer. Use a spare spring to hold transmission throttle lever against forward stop.

3) Push adjusting link to eliminate lash and pull clamp to rear so that bolt in rod bottoms in rear of slot in rod. Tighten forward clamp retaining bolt.

4) Pull throttle control rod to the rear so that bolt in rod bottoms in front of slot and tighten rear retaining bolt. Remove spare spring. Lower vehicle and reconnect throttle control rod spring.

AW-4 Transmission with All Engines

1) With ignition off, retract cable self-adjusting mechanism fully. Press cable button down and push cable plunger inward.

2) Rotate throttle lever to wide open throttle position. While holding throttle lever in position, allow cable plunger to extend. When plunger is fully extended, release throttle lever. Cable is now adjusted.

SHIFT LINKAGE

Cable Linkage

1) Place gearshift lever in "P" position and raise vehicle. Using a small screwdriver, unlock shift control cable by releasing U-shaped cable adjuster clamp. Remove cable from mounting bracket.

2) Move transmission shift lever rearward until fully seated into "P" detent. Ensure that driveshaft cannot be rotated. Snap control cable into cable mounting bracket and replace U-shaped cable adjuster clamp.

3) Lower vehicle and verify engine starting. Engine should start only with shifter in "P" or "N" position.

Rod Linkage

1) Loosen shift rod trunnion jam nuts at transmission lever. Remove shift rod-to-bellcrank lock pin. Disengage trunnion and shift rod. Place selector lever in "P" position and lock steering column. Move transmission shift lever to full rear Park position.

2) Adjust shift rod trunnion to obtain free pin fit in bellcrank arm. Tighten jam nuts. On vehicles with shift lever on column, make sure linkage lash is eliminated by pulling down on shift rod and pushing up on outer bellcrank when tightening jam nuts.

3) Check steering column lock for ease of operation. Ensure engine starts in "N" or "P", only. If starter engages in any drive gear, or does not work in "N" or "P", check for proper shift linkage adjustment or faulty neutral safety switch.

NEUTRAL SAFETY SWITCH

1) Switch combines functions of neutral safety switch and back-up light switch. With transmission linkage properly adjusted, switch should allow starter operation in "P" and "N" only.

2) To test switch, remove wire connector and test for continuity between center pin of switch and case. Continuity should

only exist when transmission is in "P" or "N".

3) Check for continuity between 2 outer pins. Continuity should exist with transmission in "R" only. There should be no continuity between either outer pin and transmission case. If any of these conditions are not met, the switch should be replaced.

4) To replace switch, unscrew from case. Move selector lever to "P" and "N" positions and check that switch operating fingers are centered in switch opening. Install switch and new seal in case. Check fluid level and add as needed.

TRANSMISSION SERVICING - M/T

1988 Jeep Cherokee

1988 MANUAL TRANSMISSION SERVICING
Jeep

Cherokee, Comanche, Grand Wagoneer, Pickup, Wagoneer, Wrangler

LUBRICATION

SERVICE INTERVALS

Transmission

Under normal driving conditions, check fluid level every 5000 miles or when serviced. Under severe driving conditions, check fluid level every 3000 miles. Transmission lubricant should be changed at 27,500 mile intervals.

Transfer Case

Check transfer case fluid every 12,000 miles and replace fluid every 30,000 miles.

CHECKING FLUID LEVEL

Transmission

Check lubricant level at transmission filler plug hole. Lubricant should be level with bottom of hole. Add lubricant as needed.

Transfer Case

Remove fill plug. Check oil level. If level is not up to fill plug opening, add lubricant until it is.

RECOMMENDED FLUID

Transmission

Recommended lubricant for Jeep with manual transmission is AMC/Jeep Manual Transmission Fluid (89 83 000 000) or 75W-90 GL-5 gear lubricant.

Transfer Cases

Transfer cases use DEXRON-II ATF.

FLUID CAPACITY

NOTE: Capacities given are approximate. Correct fluid level should be determined by level at filler plug hole.

TRANSMISSION REFILL CAPACITIES

Application	Quantity
4-Speed	
AX4	7.4 pts. (3.5L)
T176	3.5 pts. (1.7L)
5-Speed	
AX5	7.0 pts. (3.3L)
BA 10/5	3.5 pts. (1.6L)

TRANSFER CASE REFILL CAPACITIES

Application	Quantity
Model 207	5.0 pts. (2.1L)
Model 208	6.0 pts. (2.8L)
Model 228	7.0 pts. (3.3L)
Model 229	6.0 pts. (2.8L)

ADJUSTMENTS

SHIFT LINKAGE

NOTE: All Jeep models use transmission shift linkage that does not require external adjustments.

TROUBLE SHOOTING - BASIC PROCEDURES

1988 Jeep Cherokee

GENERAL TROUBLE SHOOTING

* PLEASE READ THIS FIRST *

NOTE: This is GENERAL information. This article is not intended to be specific to any unique situation or individual vehicle configuration. The purpose of this Trouble Shooting information is to provide a list of common causes to problem symptoms. For model-specific Trouble Shooting, refer to SUBJECT, DIAGNOSTIC, or TESTING articles available in the section(s) you are accessing.

ACCESSORIES & ELECTRICAL

CHARGING SYSTEM TROUBLE SHOOTING

NOTE: This is GENERAL information. This article is not intended to be specific to any unique situation or individual vehicle configuration. The purpose of this Trouble Shooting information is to provide a list of common causes to problem symptoms. For model-specific Trouble Shooting, refer to SUBJECT, DIAGNOSTIC, or TESTING articles available in the section(s) you are accessing.

BASIC CHARGING SYSTEM TROUBLE SHOOTING CHART

CONDITION	POSSIBLE CAUSE	CORRECTION
Vehicle Will Not Start	Dead battery	Check battery cells, alternator belt tension and alternator output
	Loose or corroded battery connections	Check all charging system connections
	Ignition circuit or switch malfunction	Check and replace as necessary
Alternator Light Stays On With Engine Running	Loose or worn alternator drive belt	Check alternator drive tension and condition, See Belt Adjustment in TUNE-UP article in the TUNE-UP section
	Loose alternator wiring connections	Check all charging system connections
	Short in alternator light wiring	See Indicator Warning Lights in STANDARD INSTRUMENTS in the ACCESSORIES & EQUIPMENT section
	Defective alternator stator or diodes	See Bench Tests in ALTERNATOR article
	Defective regulator	See Regulator Check in

		ALTERNATOR article
Alternator Light Stays Off With Ignition Switch ON	Blown fuse	See WIRING DIAGRAMS
	Defective alternator	See Testing in ALTERNATOR article
	Defective indicator light bulb or socket	See Indicator Warning Lights in STANDARD INSTRUMENTS in the ACCESSORIES & EQUIPMENT section
Alternator Light Stays OFF With Ignition Switch ON	Short in alternator wiring	See On-Vehicle Tests in ALTERNATOR article
	Defective rectifier bridge	See Bench Tests in ALTERNATOR article
Lights or Fuses Burn Out Frequently	Defective alternator wiring	See On-Vehicle Tests in ALTERNATOR article
	Defective regulator	See Regulator Check in ALTERNATOR article
	Defective battery	Check and replace as necessary
Ammeter Gauge Shows Discharge	Loose or worn drive belt	Check alternator drive belt tension and condition. See Belt Adjustment in TUNE-UP article in the TUNE-UP section
	Defective wiring	Check all wires and wire connections
	Defective alternator or regulator	See Bench Tests and On-Vehicle Tests in ALTERNATOR article
	Defective ammeter, or improper ammeter wiring connection	See Testing in STANDARD INSTRUMENTS in the ACCESSORIES & EQUIPMENT section
Noisy Alternator	Loose drive pulley	Tighten drive pulley attaching nut
	Loose mounting bolts	Tighten all alternator mounting bolts
	Worn or dirty bearings	See Bearing Replacement ALTERNATOR article

	Defective diodes or stator	See Bench Test in ALTERNATOR article
Battery Does Stay Charged	Loose or worn drive belt	Check alternator drive belt tension and condition. See Belt Adjustment in appropriate TUNE-UP article in the TUNE-UP section
	Loose or corroded battery connections	Check all charging system connections
	Loose alternator connections	Check all charging system connections
	Defective alternator or battery	See On-Vehicle Tests and Bench Tests in ALTERNATOR article
	Add-on electrical accessories exceeding alternator capacity	Install larger alternator
Battery Overcharged-Uses Too Much Water	Defective battery	Check alternator output and repair as necessary
	Defective alternator	See On-Vehicle Test and Bench Tests in ALTERNATOR article
	Excessive alternator voltage	Check alternator output and repair as necessary

IGNITION SYSTEM TROUBLE SHOOTING

NOTE: This is GENERAL information. This article is not intended to be specific to any unique situation or individual vehicle configuration. The purpose of this Trouble Shooting information is to provide a list of common causes to problem symptoms. For model-specific Trouble Shooting, refer to SUBJECT, DIAGNOSTIC, or TESTING articles available in the section(s) you are accessing.

Ignition Secondary Trouble Shooting Chart

START: Visually inspect Spark Plug Wires, Coil Wires, Plug Wire Boots, Rotor, and Distributor Cap for signs of damage.

OK

* To test secondary ignition system, modify a Spark Plug by attaching a ground wire to the body of the plug and

NOT OK

* Repair or replace damaged components as necessary

widening the gap to 1/4-3/8". Disconnect spark plug wire and insert test plug. Ground plug, crank engine, and check for spark.

GOOD SPARK

* If plug sparks, driveability problem is most likely NOT in the ignition system.

NO SPARK

* Remove coil wire from the distributor and attach the modified spark plug. Ground the plug and crank engine while checking for spark.

GOOD SPARK

* If plug has a good spark, the problem is in the plug wires, distributor cap, or rotor. Replace components as necessary.

NO SPARK

* Proceed to the IGNITION PRIMARY TROUBLE SHOOTING CHECK CHART below in this article.

Ignition Primary Trouble Shooting Chart

START: Visually inspect primary ignition wires for broken, frayed, split, or cut wires. Also check for loose, corroded, or disconnected connectors.

OK

* Check that battery voltage is at least 11.5 volts.

NOT OK

* Repair or replace damaged components as necessary.

NOT OK

* Replace or recharge the battery.

OK

* Check for battery voltage at the positive terminal of the coil.

OK

* Check air Gap of the Pick-Up coil in the distributor.

NOT OK

* Check resistance of ballast resistor (if used) for the correct resistance value.

OK

* Check Pick-Up coil for correct resistance value.

NOT OK

* Adjust or replace as necessary.

NOT OK

* Replace Pick-Up coil if not to specification.

OK

* Check control module for good ground connections.

OK

* If vehicle fails to run at this point, go to the appropriate article in the ENGINE PERFORMANCE section.

OK

* Check wires from the battery/ ignition switch to the coil. Also check the coil primary and secondary resistance.

NOT OK

* Replace ballast resistor if the measured resistance value is not within specification.

STARTER TROUBLE SHOOTING

NOTE: This is GENERAL information. This article is not intended to be specific to any unique situation or individual vehicle configuration. The purpose of this Trouble Shooting information is to provide a list of common causes to problem symptoms. For model-specific Trouble Shooting, refer to SUBJECT, DIAGNOSTIC, or TESTING articles available in the section(s) you are accessing.

BASIC STARTER TROUBLE SHOOTING CHART

CONDITION	POSSIBLE CAUSE	CORRECTION
Starter Fails to Operate	Dead battery or bad connections between starter and battery	Check battery charge and all wires and connections to starter
	Ignition switch faulty or misadjusted	Adjust or replace ignition switch
	Open circuit between starter switch ignition terminal on starter relay	Check and repair wires and connections as necessary
	Starter relay or starter defective	See Testing in STARTER article

	Open solenoid pull-in wire	See Testing in STARTER article
Starter Does Not Operate and Headlights Dim	Weak battery or dead cell	Charge or replace battery as necessary
	Loose or corroded battery connections	Check that battery connections are clean and tight
	Internal ground in starter windings	See Testing in STARTER article
	Grounded starter fields	See Testing in STARTERS
	Armature rubbing on pole shoes	See STARTER article
Starter Turns but Engine Does Not Rotate	Starter clutch slipping	See STARTER article
	Broken clutch housing	See STARTER article
	Pinion shaft rusted or dry	See STARTER article
	Engine basic timing incorrect	See Ignition Timing in TUNE-UP article
	Broken teeth on engine flywheel	Replace flywheel and check for starter pinion gear damage
Starter Will Not Crank Engine	Faulty overrunning clutch	See STARTER article
	Broken clutch housing	See STARTER article
	Broken flywheel teeth	Replace flywheel and check for starter pinion gear damage
	Armature shaft sheared or reduction gear teeth stripped	See STARTER article
	Weak battery	Charge or replace battery as necessary
	Faulty solenoid	See On-Vehicle Tests in STARTER article
	Poor grounds	Check all ground connections for tight and clean connections
	Ignition switch faulty or misadjusted	Adjust or replace ignition switch as necessary
Starter Cranks Engine Slowly	Battery weak or defective	Charge or replace battery as necessary

	Engine overheated	See ENGINE COOLING SYSTEM article
	Engine oil too heavy	Check that proper viscosity oil is used
	Poor battery-to-starter connections	Check that all between battery and starter are clean and tight
	Current draw too low or too high	See Bench Tests in STARTER article
	Bent armature, loose pole shoes screws or worn bearings	See STARTER article
	Burned solenoid contacts	Replace solenoid
	Faulty starter	Replace starter
Starter Engages Engine Only Momentarily	Engine timing too far advanced	See Ignition Timing in TUNE-UP article
	Overrunning clutch not engaging properly	Replace overrunning clutch. See STARTER article
	Broken starter clutch	See STARTER article
	Broken teeth on engine flywheel	Replace flywheel and check starter pinion gear for damage
	Weak drive assembly thrust spring	See STARTER article
	Weak hold-in coil	See Bench Tests in STARTER article
Starter Drive Will Not Engage	Defective point assembly	See Testing in STARTER article
	Poor point assembly ground	See Testing in STARTER article
	Defective pull-in coil	Replace starter solenoid
Starter Relay Does Not Close	Dead battery	Charge or replace battery as necessary
	Faulty wiring	Check all wiring and connections leading to relay
	Neutral safety switch faulty	Replace neutral safety switch
	Starter relay faulty	Replace starter relay

Starter Drive Will Not Disengage	Starter motor loose on mountings	Tighten starter attach bolts
	Worn drive end bushing	See STARTER article
	Damaged engine flywheel teeth	Replace flywheel and starter pinion gear for damage
	Drive yolk return spring broken or missing	Replace return spring
	Faulty ignition switch	Replace ignition switch
	Insufficient clearance between winding leads to solenoid terminal and main contact in solenoid	Replace starter solenoid
	Starter clutch not disengaging	Replace starter clutch
	Ignition starter switch contacts sticking	Replace ignition switch
Starter Relay Operates but Solenoid Does Not	Faulty solenoid switch, switch connections or	Check all wiring between relay and solenoid or replace relay or solenoid as necessary
	Broken lead or loose soldered connections	Repair wire or wire connections as necessary
Solenoid Plunger Vibrates When Switch is Engaged	Weak battery	Charge or replace battery as necessary
	Solenoid contacts corroded	Clean contacts or replace solenoid
	Faulty wiring	Check all wiring leading to solenoid
	Broken connections inside switch cover	Repair connections or replace solenoid
	Open hold-in wire	Replace solenoid
Low Current Draw	Worn brushes or weak	Replace brushes or brush springs as necessary
High Pitched Whine During Cranking Before Engine Fires but Engine Fires and Cranks Normally	Distance too great between starter pinion and flywheel	Align starter or check that correct starter and flywheel are being used
High Pitched Whine After Engine	Distance too small between starter pinion and flywheel	

Fires With Key released. Engine Fires and Cranks Normally	Flywheel runout contributes to the intermittent nature

AIR CONDITIONING & HEAT

AIR CONDITIONING TROUBLE SHOOTING

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BASIC AIR CONDITIONING TROUBLE SHOOTING CHART

CONDITION	POSSIBLE CAUSE
Compressor Not Working	• Compressor clutch circuit open. • Compressor clutch coil inoperative. • Poor clutch ground connection. • Fan belts loose. • Thermostatic switch inoperative. • Thermostatic switch not adjusted. • Ambient temperature switch open. • Superheat fuse blown.
Excessive Noise or Vibration	• Missing or loose mounting bolts. • Bad idler pulley bearings. • Fan belts not tightened correctly. • Compressor clutch contacting body. • Excessive system pressure. • Compressor oil level low. • Damaged clutch bearings. • Damaged reed valves. • Damaged compressor.
Insufficient or No Cooling; Compressor Working	• Expansion valve inoperative. • Heater control valve stuck open. • Low system pressure. • Blocked condenser fins. • Blocked evaporator fins. • Vacuum system leak. • Vacuum motors inoperative. • Control cables improperly adjusted. • Restricted air inlet. • Mode doors binding. • Blower motor inoperative. • Temperature above system capacity.

HEATER SYSTEM TROUBLE SHOOTING

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problem symptoms. For model-specific Trouble Shooting, refer to DIAGNOSTIC, or TESTING articles available in the section(s) you are accessing.

BASIC HEATER SYSTEM TROUBLE SHOOTING CHART

CONDITION	POSSIBLE CAUSE
Insufficient, Erratic, or No Heat	• Low Coolant Level • Incorrect thermostat. • Restricted coolant flow through heater core. • Heater hoses plugged. • Misadjusted control cable. • Sticking heater control valve. • Vacuum hose leaking. • Vacuum hose blocked. • Vacuum motors inoperative. • Blocked air inlet. • Inoperative heater blower motor. • Oil residue on heater core fins. • Dirt on heater core fins.
Too Much Heat	• Improperly adjusted cables. • Sticking heater control valve. • No vacuum to heater control valve. • Temperature door stuck open.
Air Flow Changes During Acceleration	• Vacuum system leak. • Bad check valve or reservoir.
Air From Defroster At All Times	• Vacuum system leak. • Improperly adjusted control cables. • Inoperative vacuum motor.
Blower Does Not Operate Correctly	• Blown fuse. • Blower motor windings open. • Resistors burned out. • Motor ground connection loose. • Wiring harness connections loose. • Blower motor switch inoperative. • Blower relay inoperative. • Fan binding or foreign object in housing. • Fan blades broken or bent.

BRAKES

BRAKE SYSTEM TROUBLE SHOOTING

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BRAKE SYSTEM TROUBLE SHOOTING CHART

CONDITION	POSSIBLE CAUSE	CORRECTION
Brakes Pull Left or Right	Incorrect tire pressure	Inflate tires to proper pressure
	Front end out of alignment	See WHEEL ALIGNMENT
	Mismatched tires	Check tires sizes
	Restricted brake lines or hoses	Check hose routing
	Loose or malfunctioning caliper	See DISC BRAKES or BRAKE SYSTEM
	Bent shoe or oily linings	See DRUM BRAKES or BRAKE SYSTEM
	Malfunctioning rear brakes	See DRUM, DISC BRAKES or BRAKE SYSTEM
	Loose suspension parts	See SUSPENSION
Noises Without Brakes Applied	Front linings worn out	Replace linings
	Dust or oil on drums or rotors	See DRUM, DISC BRAKES or BRAKE SYSTEM
Noises With Brakes Applied	Insulator on outboard shoe damaged	See DISC BRAKES or BRAKE SYSTEM
	Incorrect pads or linings	Replace pads or linings
Brake Rough, Chatters or Pulsates	Excessive lateral runout	Check rotor runout
	Parallelism not to specifications	Reface or replace rotor
	Wheel bearings not adjusted	See SUSPENSION
	Rear drums out-of-round	Reface or replace drums
	Disc pad reversed, steel against rotor	Remove and reinstall pad
Excessive Pedal Effort	Malfunctioning power unit	See POWER BRAKES or BRAKE SYSTEM
	Partial system failure	Check fluid and pipes
	Worn disc pad or lining	Replace pad or lining
	Caliper piston stuck or	

	sluggish	See DISC BRAKES or BRAKE SYSTEM
	Master cylinder piston stuck	See MASTER CYLINDERS or BRAKE SYSTEM
	Brake fade due to incorrect pads for linings	Replace pads or linings
	Linings or pads glazed	Replace pads or linings
	Worn drums	Reface or replace drums
Excessive Pedal Travel	Partial brake system failure	Check fluid and pipes
	Insufficient fluid in master cylinder	See MASTER CYLINDERS or BRAKE SYSTEM
	Air trapped in system	See BRAKE BLEEDING or BRAKE SYSTEM
	Rear brakes not adjusted	See Adjustments in DRUM BRAKES or BRAKE SYSTEM
	Bent shoe or lining	See DRUM BRAKES or BRAKE SYSTEM
	Plugged master cylinder cap	See MASTER CYLINDERS or BRAKE SYSTEM
	Improper brake fluid	Replace brake fluid
Pedal Travel Decreasing	Compensating port plugged	See MASTER CYLINDERS or BRAKE SYSTEM
	Swollen cup in master cylinder	See MASTER CYLINDERS or BRAKE SYSTEM
	Master cylinder piston not returning	See MASTER CYLINDERS or BRAKE SYSTEM
	Weak shoe retracting springs	See DRUM BRAKES BRAKE SYSTEM
	Wheel cylinder piston sticking	See DRUM BRAKES or BRAKE SYSTEM
Dragging Brakes	Master cylinder pistons not returning	See MASTER CYLINDERS BRAKE SYSTEM
	Restricted brake lines or hoses	Check line routing
	Incorrect parking brake adjustment	See DRUM BRAKES BRAKE SYSTEM

	Parking Brake cables frozen	See DRUM BRAKES BRAKE SYSTEM
	Incorrect installation of inboard disc pad	Remove and replace correctly
	Power booster output rod too long	See POWER BRAKE UNITS BRAKE SYSTEM
	Brake pedal not returning freely	See DISC, DRUM BRAKES BRAKE SYSTEM
Brakes Grab or Uneven Braking Action	Malfunction of combination valve	See CONTROL VALVE or BRAKE SYSTEM
	Malfunction of power brake unit	See POWER BRAKE UNITS or BRAKE SYSTEM
	Binding brake pedal	See DISC, DRUM BRAKES or BRAKE SYSTEM
Pulsation or Roughness	Uneven pad wear caused by caliper	See DISC BRAKES or BRAKE SYSTEM
	Uneven rotor wear	See DISC BRAKES or BRAKE SYSTEM
	Drums out-of-round	Reface or replace drums

ENGINE MECHANICAL

COOLING SYSTEM TROUBLE SHOOTING

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COOLING SYSTEM TROUBLE SHOOTING

CONDITION	POSSIBLE CAUSE	CORRECTION
Overheating	Coolant Leak	Fill/Pressure Test System
	A/C Condenser Fins Clogged	Remove/Clean Condenser
	Radiator Fins Clogged	Remove/Clean Radiator
	Thermostat Stuck Closed	Replace Thermostat
	Clogged Cooling System Passages	Clean/Flush Cooling System

	Water Pump Malfunction	Replace Water Pump
	Fan Clutch Malfunction	Replace Fan Clutch
	Retarded Ignition Timing	Reset Ignition Timing
	Cooling Fan Malfunction	Test Cooling Fan/ Circuit
	Cooling Fan Motor Malfunction	Test Fan Motor
	Cooling Fan Relay Malfunction	Test Fan Relay
	Faulty Radiator Cap	Replace Radiator Cap
	Broken/Slipping Fan Belt	Replace Fan Belt
	Restricted Exhaust	Repair Exhaust System
Corrosion	Impurities In Coolant	Clean/Flush System
Coolant Leakage	Damaged hose	Replace Hose
	Leaky Water Pump	Replace Water Pump
	Damaged Radiator Seam	Replace/Repair Radiator
	Leaky Thermostat Cover	Replace Thermostat Cover
	Cylinder Head Problem	Check Head/Head Gasket
	Leaky Freeze Plugs	Replace Freeze Plugs
Recovery System Inoperative		
	Loose and/or Defective Radiator Cap	Replace Radiator Cap
	Overflow Tube Clogged and/or Leaking	Repair Tube
	Recovery Bottle Vent Restricted	Clean Vent
No Heater Core Flow		
	Collapsed Heater Hose	Replace Heater Hose
	Plugged Heater Core	Clean/Replace Heater Core
	Faulty Heater Valve	Replace Heater Valve

GASOLINE ENGINE - MECHANICAL TROUBLE SHOOTING

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BASIC GASOLINE ENGINE - MECHANICAL TROUBLE SHOOTING CHART

CONDITION	POSSIBLE CAUSE	CORRECTION
Engine Lopes At Idle	Intake manifold-to-head leaks	Replace manifold gasket, See ENGINES
	Blown head gasket	Replace head gasket, See ENGINES
	Worn timing gears, chain or sprocket	Replace gears, chain or sprocket
	Worn camshaft lobes	Replace camshaft, See ENGINES
	Overheated engine	Check cooling system, See COOLING
	Blocked crankcase vent valve	Remove restriction
	Leaking EGR valve	Repair leak and/or replace valve
	Faulty fuel pump	Replace fuel pump
Engine Has Low Power	Leaking fuel pump	Repair leak and/or replace fuel pump
	Excessive piston-to-bore clearance	Install larger pistons, See ENGINES
	Sticking valves or weak valve springs	Check valve train components, See ENGINES
	Incorrect valve timing	Reset valve timing, See ENGINES
	Worn camshaft lobes	Replace camshaft, See ENGINES
	Blown head gasket	Replace head gasket. See ENGINES.
	Clutch slipping	Adjust pedal and/or replace components, See ENGINES
	Engine overheating	Check cooling system, See COOLING
	Auto. Trans. pressure regulator valve faulty	Replace pressure regulator valve
	Auto. Trans. fluid level too low	Add fluid as necessary
	Improper vacuum diverter valve operation	Replace vacuum diverter valve
	Vacuum leaks	Inspect vacuum system and repair as required
	Leaking piston rings	Replace piston rings, See ENGINES
Faulty High Speed Operation	Low fuel pump volume	Replace fuel pump
	Leaking valves or worn	Replace valves and/or springs, See ENGINES
	Incorrect valve timing	Reset valve timing,See ENGINES
	Intake manifold restricted	Remove restriction
	Worn distributor shaft	Replace distributor
Faulty Acceleration	Improper fuel pump stroke	Remove pump and reset pump stroke

	Incorrect ignition timing	Reset ignition timing, See TUNE-UP
	Leaking valves	Replace valves, See ENGINES
	Worn fuel pump diaphragm or piston	Replace diaphragm or piston
Intake Backfire	Improper ignition timing	Reset ignition timing, See TUNE-UP
	Faulty accelerator pump discharge	Replace accelerator pump
	Improper choke operation	Check choke and adjust as required
	Defective EGR valve	Replace EGR valve
	Fuel mixture too lean	Reset air/fuel mixture, See TUNE-UP
	Choke valve initial clearance too large	Reset choke valve initial clearance
Exhaust Backfire	Vacuum leak	Inspect and repair vacuum system
	Faulty vacuum diverter valve	Replace vacuum diverter valve
	Faulty choke operation	Check choke and adjust as required
	Exhaust system leak	repair exhaust system leak
Engine Detonation	Ignition timing too far advanced	Reset ignition timing, See TUNE-UP
	Faulty ignition system	Check ignition timing, See TUNE-UP
	Spark plugs loose or faulty	Retighten or replace plugs
	Fuel delivery system clogged	Inspect lines, pump and filter for clog
	EGR valve inoperative	Replace EGR valve
	PCV system inoperative	Inspect and/or replace hoses or valve
	Vacuum leaks	Check vacuum system and repair leaks
	Excessive combustion chamber deposits	Remove built-up deposits
	Leaking, sticking or broken valves	Inspect and/or replace valves
External Oil Leakage	Fuel pump improperly seated or worn gasket	Remove pump, replace gasket and seat properly
	Oil pan gasket broken or pan bent	Straighten pan and replace gasket
	Timing chain cover gasket broken	Replace timing chain cover gasket
	Rear main oil seal worn	Replace rear main oil seal
	Oil pan drain plug not seated properly	Remove and reinstall drain plug
	Camshaft bearing drain hole blocked	Remove restriction
	Oil pressure sending switch leaking	Remove and reinstall sending switch

Excessive Oil Consumption	Worn valve stems or guides	Replace stems or guides, See ENGINES
	Valve "O" ring seals damaged	Replace "O" ring seals, See ENGINES
	Plugged oil drain back holes	Remove restrictions
	Improper PCV valve operation	Replace PCV valve
	Engine oil level too high	Remove excess oil
	Engine oil too thin	Replace thicker oil
	Valve stem oil deflectors damaged	Replace oil deflectors
	Incorrect piston rings	Replace piston rings, See ENGINES
	Piston ring gaps not staggered	Reinstall piston rings, See ENGINES
	Insufficient piston ring tension	Replace rings, See ENGINES
	Piston ring grooves or oil return slots clogged	Replace piston rings, See ENGINES
	Piston rings sticking in grooves	Replace piston rings, See ENGINES
	Piston ring grooves excessively worn	Replace piston and rings, See ENGINES
	Compression rings installed upside down	Replace compression rings correctly, See ENGINES
	Worn or scored cylinder walls	Rebore cylinders or replace block
	Mismatched oil ring expander and rail	Replace oil ring expander and rail, See ENGINES
	Intake gasket dowels too long	Replace intake gasket dowels
	Excessive main or connecting rod bearing clearance	Replace main or connecting rod bearings, See ENGINES
No Oil Pressure	Low oil level	Add oil to proper level
	Oil pressure sender or gauge broken	Replace sender or gauge
	Oil pump malfunction	Remove and overhaul oil pump, See ENGINES
	Oil pressure relief valve sticking	Remove and reinstall valve
	Oil pump passages blocked	Overhaul oil pump, See ENGINES
	Oil pickup screen or tube blocked	remove restriction
	Loose oil inlet tube	Tighten oil inlet tube
	Loose camshaft bearings	Replace camshaft bearings, See ENGINES
	Internal leakage at oil passages	Replace block or cylinder head
Low Oil Pressure	Low engine oil level	Add oil to proper level
	Engine oil too thin	Remove and replace with thicker oil
	Excessive oil pump clearance	Reduce oil pump clearance, See ENGINES
	Oil pickup tube or screen blocked	Remove restrictions
	Main, rod or cam bearing clearance excessive	Replace bearing to reduce clearance, See

High Oil Pressure	Improper grade of oil	Replace with proper oil
	Oil pressure relief valve stuck closed	Eliminate binding
	Oil pressure sender or gauge faulty	Replace sender or gauge
Noisy Main Bearings	Inadequate oil supply	Check oil delivery to main bearings
	Excessive main bearing clearance	Replace main bearings, See ENGINES
	Excessive crankshaft end play	Replace crankshaft, See ENGINES
	Loose flywheel or torque converter	Tighten attaching bolts
	Loose or damaged vibration damper	Tighten or replace vibration damper
	Crankshaft journals out-of-round	Re-grind crankshaft journals
	Excessive belt tension	Loosen belt tension
Noisy Connecting Rods	Excessive bearing clearance or missing bearing	Replace bearing, See ENGINES
	Crankshaft rod journal out-of-round	Re-grind crankshaft journal
	Misaligned connecting rod or cap	Remove rod or cap and realign
	Incorrectly tightened rod bolts	Remove and re-tighten rod bolts
Noisy Pistons and Rings	Excessive piston-to-bore clearance	Install larger pistons, See ENGINES
	Bore tapered or out-of-round	Rebore block
	Piston ring broken	Replace piston rings, See ENGINES
	Piston pin loose or seized	Replace piston pin, See ENGINES
	Connecting rods misaligned	Realign connecting rods
	Ring side clearance too loose or tight	Replace with larger or smaller rings
	Carbon build-up on piston	Remove carbon
Noisy Valve Train	Worn or bent push rods	Replace push rods, See ENGINES
	Worn rocker arms or bridged pivots	Replace push rods, See ENGINES
	Dirt or chips in valve lifters	Remove lifters and remove dirt/chips
	Excessive valve lifter leak-down	Replace valve lifters, See ENGINES
	Valve lifter face worn	Replace valve lifters, See ENGINES
	Broken or cocked valve springs	replace or reposition springs
	Too much valve stem-to-guide clearance	Replace valve guides, See ENGINES
	Valve bent	Replace valve, See ENGINES
	Loose rocker arms	Retighten rocker arms, See ENGINES
	Excessive valve seat run-out	Reface valve seats, See ENGINES

	Missing valve lock	Install new valve lock
	Excessively worn camshaft lobes	Replace camshaft, See ENGINES
	Plugged valve lifter oil holes	Eliminate restriction or replace lifter
	Faulty valve lifter check ball	Replace lifter check ball, See ENGINES
	Rocker arm nut installed upside down	Remove and reinstall correctly
	Valve lifter incorrect for engine	Remove and replace valve lifters
	Faulty push rod seat or lifter plunger	Replace plunger or push rod
Noisy Valves	Improper valve lash	Re-adjust valve lash, See ENGINES
	Worn or dirty valve lifters	Clean and/or replace lifters
	Worn valve guides	Replace valve guides, See ENGINES
	Excessive valve seat or face run-out	Reface seats or valve face
	Worn camshaft lobes	Replace camshaft, See ENGINES
	Loose rocker arm studs	Re-tighten rocker arm studs, See ENGINES
	Bent push rods	Replace push rods, See ENGINES
	Broken valve springs	Replace valve springs, See ENGINES
Burned,Sticking or Broken Valves	Weak valve springs or warped valves	Replace valves and/or springs, See ENGINES
	Improper lifter clearance	Re-adjust clearance or replace lifters
	Worn guides or improper guide clearance	Replace valve guides, See ENGINES
	Out-of-round valve seats or improper seat width	Re-grind valve seats
	Gum deposits on valve stems, seats or guides	Remove deposits
	Improper spark timing	Re-adjust spark timing
Broken Pistons/Rings	Undersize pistons	Replace with larger pistons, See ENGINES
	Wrong piston rings	Replace with correct rings, See ENGINES
	Out-of-round cylinder bore	Re-bore cylinder bore
	Improper connecting rod alignment	Remove and realign connecting rods
	Excessively worn ring grooves	Replace pistons, See ENGINES
	Improperly assembled piston pins	Re-assemble pin-to -piston, See ENGINES
	Insufficient ring gap clearance	Install new rings, See ENGINES
	Engine overheating	Check cooling system
	Incorrect ignition timing	Re-adjust ignition timing, See TUNE-UP
Excessive Exhaust Noise	Leaks at manifold to head, or to pipe	Replace manifold or pipe gasket
	Exhaust manifold	Replace exhaust

	cracked or broken	manifold, See ENGINES

ENGINE PERFORMANCE

CARBURETOR TROUBLE SHOOTING:

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BASIC COLD START SYMPTOMS TROUBLE SHOOTING CHART

CONDITION	POSSIBLE CAUSE	CORRECTION
Engine Won't Start	Choke not closing	Check choke operation, see FUEL SYSTEMS
	Choke linkage bent	Check linkage, see FUEL SYSTEM
Engine Starts, Then Dies	Choke vacuum kick setting too wide	Check setting and adjust see, FUEL SYSTEMS
	Fast idle RPM too low	Reset RPM to specif- ication, see TUNE-UP
	Fast idle cam index incorrect	Reset fast idle cam index, see FUEL SYSTEMS
	Vacuum leak	Inspect vacuum system for leaks
	Low fuel pump outlet	Repair or replace pump, see FUEL SYSTEMS
	Low carburetor fuel level	Check float setting see FUEL SYSTEM
Engine Quits Under Load	Choke vacuum kick setting incorrect	Reset vacuum kick setting,see FUEL SYSTEMS
	Fast idle cam index incorrect	Reset fast idle cam index, see FUEL SYSTEM
	Incorrect hot fast idle speed RPM	Reset fast idle RPM, see TUNE-UP
Engine Starts, Runs Up,Then Idles, Slowly With Black Smoke	Choke vacuum kick set too narrow	Reset vacuum kick, see FUEL SYSTEMS
	Fast idle cam index	Reset fast idle cam

	incorrect	index, see FUEL SYSTEMS
	Hot fast idle RPM too low	Reset fast idle RPM, see TUNE-UP

BASIC HOT START SYMPTOMS TROUBLE SHOOTING CHART

CONDITION	POSSIBLE CAUSE	CORRECTION
Engine Won't Start	Engine flooded	Allow fuel to evaporate

BASIC COLD ENGINE DRIVEABILITY SYMPTOMS TROUBLE SHOOTING CHART

CONDITION	POSSIBLE CAUSE	CORRECTION
Engine Stalls in Gear	Choke vacuum kick setting incorrect	Reset choke vacuum kick, see FUEL SYSTEMS
	Fast idle RPM incorrect	Reset fast idle RPM, see TUNE-UP
	Fast idle cam index incorrect	Reset fast idle cam see FUEL SYSTEMS
Acceleration Sag or Stall	Defective choke control switch	Replace choke control switch
	Choke vacuum kick setting incorrect	Reset choke vacuum kick see, FUEL SYSTEMS
	Float level incorrect (too low)	Adjust float level, FUEL SYSTEMS
	Accelerator pump defective	Repair or replace pump see FUEL SYSTEMS
	Secondary throttles not closed	Inspect lockout adjustment,see FUEL SYSTEMS
Sag or Stall After Warmup	Defective choke control switch	Replace choke control switch, see FUEL SYSTEMS
	Defective accelerator pump	Replace pump, see FUEL SYSTEMS
	Float level incorrect (too low)	Adjust float level, see FUEL SYSTEMS
Backfiring & Black Smoke	Plugged heat crossover system	Remove restriction

BASIC WARM ENGINE DRIVEABILITY SYMPTOMS TROUBLE SHOOTING CHART

CONDITION	POSSIBLE CAUSE	CORRECTION
Hesitation With Small Amount of Gas Pedal Movement	Vacuum leak	Inspect vacuum lines
	Accelerator pump weak or inoperable	Replace pump, see FUEL SYSTEMS
	Float level setting too low	Reset float level, see,FUEL SYSTEMS
	Metering rods sticking or binding	Inspect and/or replace rods, see FUEL SYSTEMS
	Carburetor idle or transfer system plugged	Inspect system and remove restriction
	Frozen or binding heated air inlet	Inspect heated air door for binding
Hesitation With Heavy Gas Pedal Movement	Defective accelerator pump	Replace pump, see FUEL SYSTEMS
	Metering rod carrier sticking or binding	Remove restriction
	Large vacuum leak	Inspect vacuum system and repair leak
	Float level setting too low	Reset float level, see FUEL SYSTEMS
	Defective fuel pump, lines or filter	Inspect pump, lines and filter
	Air door setting incorrect	Adjust air door setting, see FUEL

DIESEL ENGINE TROUBLE SHOOTING

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NOTE: Diesel engines mechanical diagnosis is the same as gasoline engines for items such as noisy valves, bearings, pistons, etc. The following trouble shooting covers only items pertaining to diesel engines.

BASIC DIESEL ENGINE TROUBLE SHOOTING CHART

CONDITION	POSSIBLE CAUSE	CORRECTION
Engine Won't Crank	Bad battery connections or dead batteries	Check connections and/or replace

		batteries
	Bad starter connections or bad starter	Check connections and/or replace batteries
Engine Cranks Slowly, Won't Start	Bad battery connections or dead batteries	Check connections and/or replace batteries
	Engine oil too heavy	Replace engine oil
Engine Cranks Normally, But Will Not Start	Glow plugs not functioning	Check glow plug system, see FUEL SYSTEMS
	Glow plug control not functioning	Check controller, see FUEL SYSTEMS
	Fuel not injected into cylinders	Check fuel injectors, see FUEL SYSTEMS
	No fuel to injection pump	Check fuel delivery system
	Fuel filter blocked	Replace fuel filter
	Fuel tank filter blocked	Replace fuel tank filter
	Fuel pump not operating	Check pump operation and/or replace pump
	Fuel return system blocked	Inspect system and remove restriction
	No voltage to fuel solenoid	Check solenoid and connections
	Incorrect or contaminated fuel	Replace fuel
	Incorrect injection pump timing	Re-adjust pump timing, see FUEL SYSTEMS
	Low compression	Check valves, pistons, rings, see ENGINES
	Injection pump malfunction	Inspect and/or replace injection pump
Engine Starts, Won't Idle	Incorrect slow idle adjustment	Reset idle adjustment, see TUNE-UP
	Fast idle solenoid malfunctioning	Check solenoid and connections
	Fuel return system blocked	Check system and remove restrictions
	Glow plugs go off too soon	See glow plug diagnosis in FUEL SYSTEMS
	Injection pump timing incorrect	Reset pump timing, see FUEL SYSTEMS
	No fuel to injection pump	Check fuel delivery system
	Incorrect or contaminated fuel	Replace fuel
	Low compression	Check valves, piston, rings, see ENGINES
	Injection pump malfunction	Replace injection pump, see FUEL SYSTEMS
	Fuel solenoid closes in RUN position	Check solenoid and connections
Engines Starts/ Idles Rough W/out Smoke or Noise	Incorrect slow idle adjustment	Reset slow idle, see TUNE-UP
	Injection line fuel leaks	Check lines and connections
	Fuel return system blocked	Check lines and connections

	Air in fuel system	Bleed air from system
	Incorrect or contaminated fuel	Replace fuel
	Injector nozzle malfunction	Check nozzles, see FUEL SYSTEMS
Engines Starts and Idles Rough W/out Smoke or Noise, But Clears After Warm-Up	Injection pump timing incorrect	Reset pump timing, see FUEL SYSTEMS
	Engine not fully broken in	Put more miles on engine
	Air in system	Bleed air from system
	Injector nozzle malfunction	Check nozzles, see FUEL SYSTEMS
Engine Idles Correctly, Misfires Above Idle	Blocked fuel filter	Replace fuel filter
	Injection pump timing incorrect	Reset pump timing, see FUEL SYSTEMS
	Incorrect or contaminated fuel	Replace fuel
Engine Won't Return To Idle	Fast idle adjustment incorrect	Reset fast idle, see TUNE-UP
	Internal injection pump malfunction	Replace injection pump, see FUEL SYSTEMS
	External linkage binding	Check linkage and remove binding
Fuel Leaks On Ground	Loose or broken fuel line	Check lines and connections
	Internal injection pump seal leak	Replace injection pump, see FUEL SYSTEMS
Cylinder Knocking Noise	Injector nozzles sticking open	Test injectors, see FUEL SYSTEMS
	Very low nozzle opening pressure	Test injectors and/or replace
Loss of Engine Power	Restricted air intake	Remove restriction
	EGR valve malfunction	Replace EGR valve
	Blocked or damaged exhaust system	Remove restriction and/or replace components
	Blocked fuel tank filter	Replace filter
	Restricted fuel filter	Remove restriction and/or replace filter
	Block vent in gas cap	Remove restriction and/or replace cap
	Tank-to-injection pump fuel supply blocked	Check fuel lines and connections
	Blocked fuel return system	Remove restriction
	Incorrect or contaminated fuel	Replace fuel
	Blocked injector nozzles	Check nozzle for blockage, see FUEL SYSTEMS
	Low compression	Check valves, rings, pistons, see ENGINES
Loud Engine Noise With Black Smoke	Basic timing incorrect	Reset timing, see FUEL SYSTEMS
	EGR valve malfunction	Replace EGR valve
	Internal injection pump malfunction	Replace injection pump, see FUEL SYSTEMS

	Incorrect injector pump housing pressure	Check pressure, see FUEL SYSTEMS
Engine Overheating	Cooling system leaks	Check cooling system and repair leaks
	Belt slipping or damaged	Check tension and/or replace belt
	Thermostat stuck closed	Remove and replace thermostat, see ENGINE COOLING
	Head gasket leaking	Replace head gasket
Oil Light on at Idle	Low oil pump pressure	Check oil pump operation, see ENGINES
	Oil cooler or line restricted	Remove restriction and/or replace cooler
Engine Won't Shut Off	Injector pump fuel solenoid does not return fuel valve to OFF position	Remove and check solenoid and replace if needed
	VACUUM PUMP DIAGNOSIS	
Excessive Noise	Loose pump-to-drive assembly screws	Tighten screws
	Loose tube on pump assembly	Tighten tube
	Valves not functioning properly	Replace valves
Oil Leakage	Loose end plug	Tighten end plug
	Bad seal crimp	Remove and re-crimp seal

FUEL INJECTION TROUBLE SHOOTING

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BASIC FUEL INJECTION TROUBLE SHOOTING CHART

CONDITION	POSSIBLE CAUSE	CORRECTION
Engine Won't Start (Cranks Normally)	Cold start valve inoperative	Test valve and circuit
	Poor connection;vacuum or wiring	Check vacuum and electrical connections
	Contaminated fuel	Test fuel for water or alcohol
	Defective fuel pump relay or circuit	Test relay and wiring
	Battery too low	Charge and test battery

	Low fuel pressure	Test pressure regulator and fuel pump, check for restricted lines and filters
	No distributor reference pulses	Repair ignition system as necessary
	Open coolant temperature sensor circuit	Test sensor and wiring
	Shorted W.O.T. switch in T.P.S.	Disconnect W.O.T. switch, engine should start
	Defective ECM	Replace ECM
	Fuel tank residual pressure valve leaks	Test for fuel pressure drop after shut down
Hard Starting	Disconnected hot air tube to air cleaner	Reconnect tube and test control valve
	Defective Idle Air Control (IAC) valve	Test valve operation and circuit
	Shorted, open or misadjusted T.P.S.	Test and adjust or replace T.P.S.
	EGR valve open	Test EGR valve and control circuit
	Poor Oxygen sensor signal	Test for shorted or circuit
	Incorrect mixture from PCV system	Test PCV for flow, check sealing of oil filter cap
Poor High Speed Operation	Low fuel pump volume	Faulty pump or restricted fuel lines or filters
	Poor MAP sensor signal	Test MAP sensor, vacuum hose and wiring
	Poor Oxygen sensor signal	Test for shorted or open sensor or circuit
	Open coolant temperature sensor circuit	Test sensor and wiring
	Faulty ignition operation	Check wires for cracks or poor connections, test secondary voltage with oscilloscope
	Contaminated fuel	Test fuel for water

		or alcohol
	Intermittent ECM ground	Test ECM ground connection for resistance
	Restricted air cleaner	Replace air cleaner
	Restricted exhaust system	Test for exhaust manifold back pressure
	Poor MAF sensor signal	Check leakage between sensor and manifold
	Poor VSS signal	If tester for ALCL hook-up is available check that VSS reading matches speedometer
Ping or Knock on Acceleration	Poor Knock sensor signal	Test for shorted or open sensor or circuit
	Poor Baro sensor signal	Test for shorted or open sensor or circuit
	Improper ignition timing	See VEHICLE EMISSION CONTROL LABEL (where applicable)
	Check for engine overheating problems	Low coolant, loose belts or electric cooling fan inoperative

NOTE: For additional electronic fuel injection trouble shooting information, see the appropriate article in the ENGINE PERFORMANCE section (not all vehicles have Computer Engine Control articles). Information is provided there for diagnosing fuel system problems on vehicles with electronic fuel injection.

IGNITION SYSTEM TROUBLE SHOOTING

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Ignition Secondary Trouble Shooting Chart

START: Visually inspect Spark Plug Wires, Coil Wires, Plug Wire Boots, Rotor, and Distributor Cap for signs of damage.

OK

* To test secondary ignition system, modify a Spark Plug by attaching a ground wire to the body of the plug and widening the gap to 1/4-3/8". Disconnect spark plug wire and insert test plug. Ground plug, crank engine, and check for spark.

NOT OK

* Repair or replace damaged components as necessary

GOOD SPARK

* If plug sparks, driveability problem is most likely NOT in the ignition system.

NO SPARK

* Remove coil wire from the distributor and attach the modified spark plug. Ground the plug and crank engine while checking for spark.

GOOD SPARK

* If plug has a good spark, the problem is in the plug wires, distributor cap, or rotor. Replace components as necessary.

NO SPARK

* Proceed to the IGNITION PRIMARY TROUBLE SHOOTING CHECK CHART below in this article.

Ignition Primary Trouble Shooting Chart

START: Visually inspect primary ignition wires for broken, frayed, split, or cut wires. Also check for loose, corroded, or disconnected connectors.

OK

* Check that battery voltage is at least 11.5 volts.

NOT OK

* Repair or replace damaged components as necessary.

NOT OK

* Replace or recharge the battery.

OK

* Check for battery voltage at the positive terminal of the coil.

OK

* Check air Gap of the Pick-Up coil in the distributor.

NOT OK

* Check resistance of ballast resistor (if used) for the correct resistance value.

OK

* Check Pick-Up coil for correct resistance value.

NOT OK

* Adjust or replace as necessary.

NOT OK

* Replace Pick-Up coil if not to specification.

OK

* Check control module for good ground connections.

OK

* If vehicle fails to run at this point, go to the appropriate article in the ENGINE PERFORMANCE section.

OK

* Check wires from the battery/ ignition switch to the coil. Also check the coil primary and secondary resistance.

NOT OK

* Replace ballast resistor if the measured resistance value is not within specification.

STARTER TROUBLE SHOOTING

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BASIC STARTER TROUBLE SHOOTING CHART

CONDITION	POSSIBLE CAUSE	CORRECTION
Starter Fails to Operate	Dead battery or bad connections between starter and battery	Check battery charge and all wires and connections to starter

	Ignition switch faulty or misadjusted	Adjust or replace ignition switch
	Open circuit between starter switch ignition terminal on starter relay	Check and repair wires and connections as necessary
	Starter relay or starter defective	See Testing in STARTER article
	Open solenoid pull-in wire	See Testing in STARTER article
Starter Does Not Operate and Headlights Dim	Weak battery or dead cell	Charge or replace battery as necessary
	Loose or corroded battery connections	Check that battery connections are clean and tight
	Internal ground in starter windings	See Testing in STARTER article
	Grounded starter fields	See Testing in STARTERS
	Armature rubbing on pole shoes	See STARTER article
Starter Turns but Engine Does Not Rotate	Starter clutch slipping	See STARTER article
	Broken clutch housing	See STARTER article
	Pinion shaft rusted or dry	See STARTER article
	Engine basic timing incorrect	See Ignition Timing in TUNE-UP article
	Broken teeth on engine flywheel	Replace flywheel and check for starter pinion gear damage
Starter Will Not Crank Engine	Faulty overrunning clutch	See STARTER article
	Broken clutch housing	See STARTER article
	Broken flywheel teeth	Replace flywheel and check for starter pinion gear damage
	Armature shaft sheared or reduction gear teeth stripped	See STARTER article
	Weak battery	Charge or replace battery as necessary
	Faulty solenoid	See On-Vehicle Tests in STARTER article
	Poor grounds	Check all ground

		connections for tight and clean connections
	Ignition switch faulty or misadjusted	Adjust or replace ignition switch as necessary
Starter Cranks Engine Slowly	Battery weak or defective	Charge or replace battery as necessary
	Engine overheated	See ENGINE COOLING SYSTEM article
	Engine oil too heavy	Check that proper viscosity oil is used
	Poor battery-to-starter connections	Check that all between battery and starter are clean and tight
	Current draw too low or too high	See Bench Tests in STARTER article
	Bent armature, loose pole shoes screws or worn bearings	See STARTER article
	Burned solenoid contacts	Replace solenoid
	Faulty starter	Replace starter
Starter Engages Engine Only Momentarily	Engine timing too far advanced	See Ignition Timing in TUNE-UP article
	Overrunning clutch not engaging properly	Replace overrunning clutch. See STARTER article
	Broken starter clutch	See STARTER article
	Broken teeth on engine flywheel	Replace flywheel and check starter pinion gear for damage
	Weak drive assembly thrust spring	See STARTER article
	Weak hold-in coil	See Bench Tests in STARTER article
Starter Drive Will Not Engage	Defective point assembly	See Testing in STARTER article
	Poor point assembly ground	See Testing in STARTER article
	Defective pull-in coil	Replace starter solenoid
Starter Relay	Dead battery	Charge or replace

Does Not Close		battery as necessary
	Faulty wiring	Check all wiring and connections leading to relay
	Neutral safety switch faulty	Replace neutral safety switch
	Starter relay faulty	Replace starter relay
Starter Drive Will Not Disengage	Starter motor loose on mountings	Tighten starter attach bolts
	Worn drive end bushing	See STARTER article
	Damaged engine flywheel teeth	Replace flywheel and starter pinion gear for damage
	Drive yolk return spring broken or missing	Replace return spring
	Faulty ignition switch	Replace ignition switch
	Insufficient clearance between winding leads to solenoid terminal and main contact in solenoid	Replace starter solenoid
	Starter clutch not disengaging	Replace starter clutch
	Ignition starter switch contacts sticking	Replace ignition switch
Starter Relay Operates but Solenoid Does Not	Faulty solenoid switch, switch connections or	Check all wiring between relay and solenoid or replace relay or solenoid as necessary
	Broken lead or loose soldered connections	Repair wire or wire connections as necessary
Solenoid Plunger Vibrates When Switch is Engaged	Weak battery	Charge or replace battery as necessary
	Solenoid contacts corroded	Clean contacts or replace solenoid
	Faulty wiring	Check all wiring leading to solenoid
	Broken connections inside switch cover	Repair connections or replace solenoid
	Open hold-in wire	Replace solenoid
Low Current Draw	Worn brushes or weak	Replace brushes or brush springs as necessary

High Pitched Whine During Cranking Before Engine Fires but Engine Fires and Cranks Normally	Distance too great between starter pinion and flywheel	Align starter or check that correct starter and flywheel are being used
High Pitched Whine After Engine Fires With Key released. Engine Fires and Cranks Normally	Distance too small between starter pinion and flywheel Flywheel runout contributes to the intermittent nature	

TUNE-UP TROUBLE SHOOTING - GAS ENGINE VEHICLES

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BASIC SPARK PLUG TROUBLE SHOOTING CHARTS

CONDITION	POSSIBLE CAUSE	CORRECTION
Normal Spark Plug Condition	Light Tan or Gray deposits	No Action
	Electrode not burned or fouled	No Action
	Gap tolerance not changed	No Action
Cold Fouling or Carbon Deposits	Overrich air/fuel mixture	Adjust air/fuel mixture, see ENGINE PERFORMANCE section
	Faulty choke	Replace choke assembly, see ENGINE PERFORMANCE section
	Clogged air filter	Clean and/or replace air filter
	Incorrect idle speed or dirty carburetor	Reset idle speed and/ or clean carburetor
	Faulty ignition wires	Replace ignition wiring
	Prolonged operation at idle	Shut engine off during long idle
	Sticking valves or worn valve guide seals	Check valve train
Wet Fouling or Oil Deposits	Worn rings and pistons	Install new rings and pistons

	Excessive cylinder wear	Rebore or replace block
	Excessive valve guide clearance	Worn or loose bearing
Gap Bridged	Deposits in combustion chamber becoming fused to electrode	Clean combustion chamber of deposits
Blistered Electrode	Engine overheating	Check cooling system
	Wrong type of fuel	Replace with correct fuel
	Loose spark plugs	Retighten spark plugs
	Over-advanced ignition timing	Reset ignition timing see ENGINE PERFORMANCE
Pre-Ignition or Melted Electrodes	Incorrect type of fuel	Replace with correct fuel
	Incorrect ignition timing	Reset ignition timing see ENGINE PERFORMANCE
	Burned valves	Replace valves
	Engine Overheating	Check cooling system
	Wrong type of spark plug, too hot	Replace with correct spark plug, see ENGINE PERFORMANCE
Chipped Insulators	Severe detonation	Check for over-advanced timing or combustion
	Improper gapping procedure	Re-gap spark plugs
Rust Colored Deposits	Additives in unleaded fuel	Try different fuel brand
Water In Combustion Chamber	Blown head gasket or cracked head	Repair or replace head or head gasket

NOTE: Before diagnosing an electronic ignition system, ensure that all wiring is connected properly between distributor, wiring connector and spark plugs. Ignition problem will show up either as: Engine Will Not Start or Engine Runs Rough.

BASIC ELECTRONIC IGNITION TROUBLE SHOOTING CHARTS

CONDITION	POSSIBLE CAUSE	CORRECTION
Engine Won't Start	Open circuit between distributor and bulkhead connector	Repair circuit
	Open circuit between bulkhead connector and	Repair circuit

	ignition switch	
	Open circuit between ignition switch and starter solenoid	Repair circuit
Engine Runs Rough	Fuel lines leaking or clogged	Tighten fitting, remove restriction
	Initial timing incorrect	Reset ignition timing see ENGINE PERFORMANCE
	Centrifugal advance malfunction	Repair distributor advance
	Defective spark plugs or wiring	Replace plugs or plug wiring
Component Failure	Spark arc-over on cap, rotor or coil	Replace cap, rotor or or coil
	Defective pick-up coil	Replace pick-up coil
	Defective ignition coil	Replace ignition coil
	Defective vacuum unit	Replace vacuum unit
	Defective control module	Replace control module

BASIC ELECTRONIC IGNITION TROUBLE SHOOTING
CHARTS - USING OSCILLOSCOPE PATTERNS

CONDITION	POSSIBLE CAUSE	CORRECTION
Firing Voltage Lines are the Same, but Abnormally High	Retarded ignition timing	Reset ignition timing, see ENGINE PERFORMANCE section
	Fuel mixture too lean	Readjust carburetor, see ENGINE PERFORMANCE
	High resistance in coil wire	Replace coil wire
	Corrosion in coil tower terminal	Clean and/or replace coil
	Corrosion in distributor coil terminal	Clean and/or replace distributor cap
Firing Voltage Lines are the Same but Abnormally Low	Fuel mixture too rich	Readjust carburetor, see ENGINE PERFORMANCE
	Breaks in coil wire causing arcing	Replace coil wire
	Cracked coil tower causing arcing	Replace coil
	Low coil output	Replace coil
	Low engine compression	Determine cause and

		repair
One or More, But Not All Firing Voltage Lines are Higher Than Others	Carburetor idle mixture not balanced	Readjust carburetor, see ENGINE PERFORMANCE
	EGR valve stuck open	Clean and/or replace valve
	High resistance in spark plug wires	Replace spark plug wires
	Cracked or broken spark plug insulator	Replace spark plugs
	Intake vacuum leak	Repair leak
	Defective spark plugs	Replace spark plugs
	Corroded spark plug terminals	Replace spark plugs
One or More, But Not All Firing Voltage Lines Are Lower Than Others	Curb idle mixture not balanced	Readjust carburetor, see ENGINE PERFORMANCE
	Breaks in plug wires causing arcing	Replace plug wires
	Cracked coil tower causing arcing	Replace coil
	Low compression	Determine cause and repair
	Defective spark plugs	Replace spark plugs
	Corroded spark plugs	Replace spark plugs
Cylinders Not Firing	Cracked distributor cap terminals	Replace distributor cap
	Shorted spark plug wire	Determine cause and repair
	Mechanical problem in engine	Determine cause and repair
	Defective spark plugs	Replace spark plugs
	Spark plugs fouled	Replace spark plugs

BASIC DRIVEABILITY PROBLEMS TROUBLE SHOOTING TABLE

CONDITION	POSSIBLE CAUSE	CORRECTION
Hard Starting	Binding carburetor linkage	Eliminate binding
	Binding choke linkage	Eliminate binding
	Binding choke piston	Eliminate binding
	Restricted choke vacuum	Check vacuum lines for blockage

	Worn or dirty needle valve and seat	Clean carburetor, see ENGINE PERFORMANCE
	Float sticking	Readjust or replace float see the ENGINE PERFORMANCE section
	Incorrect choke adjustment	Reset choke adjustment see ENGINE PERFORMANCE
	Defective coil	Replace coil
	Improper spark plug gap	Regap spark plugs
	Incorrect ignition timing	Reset ignition timing see ENGINE PERFORMANCE
Detonation	Over-advanced ignition timing	Reset ignition timing see ENGINE PERFORMANCE
	Defective spark plugs	Replace spark plugs
	Fuel lines clogged	Clean fuel lines
	EGR system malfunction	Check and repair EGR system
	PCV system malfunction	Repair PCV system
	Vacuum leaks	Check and repair vacuum system
	Loose fan belts	Tighten or replace fan belts, see ENGINE PERFORMANCE
	Restricted airflow	Remove restriction
	Vacuum advance malfunction	Check distributor operation
Dieseling	Binding carburetor linkage	Eliminate binding
	Binding throttle linkage	Eliminate blinding
	Binding choke linkage or fast idle cam	Eliminate binding
	Defective idle solenoid	Replace idle solenoid see ENGINE PERFORMANCE
	Improper base idle speed	Reset idle speed, see see ENGINE PERFORMANCE
	Incorrect ignition timing	Reset ignition timing see ENGINE PERFORMANCE
	Incorrect idle mixture setting	Reset idle mixture, see ENGINE PERFORMANCE
Faulty Acceleration	Incorrect ignition timing	Reset ignition timing see ENGINE PERFORMANCE

	Engine cold and choke too lean	Adjust choke and allow engine to warm-up
	Defective spark plugs	Replace spark plugs
	Defective coil	Replace coil
Faulty Low Speed Operation	Clogged idle transfer slots	Clean idle transfer slots, see FUEL
	Restricted idle air bleeds and passages	Disassemble and clean carburetor, see FUEL
	Clogged air cleaner	Replace air filter
	Defective spark plugs	Replace spark plugs
	Defective ignition wires	Replace ignition wire see ENGINE PERFORMANCE
	Defective distributor cap	Replace distributor cap
Faulty High Speed Operation	Incorrect ignition timing	Reset ignition timing see ENGINE PERFORMANCE
	Defective distributor centrifugal advance	Replace advance mechanism
	Defective distributor vacuum advance	Replace advance unit
	Incorrect spark plugs or plug gap	Check gap and/or replace spark plugs
	Faulty choke operation	Check choke and repair as required
	Clogged vacuum passages	Remove restrictions
	Improper size or clogged main jet	Check jet size and clean, see FUEL
	Restricted air cleaner	Check filter and replace as necessary
	Defective distributor cap, rotor or coil	Replace cap, rotor or coil
Misfire at All Speeds	Defective spark plugs	Replace spark plugs
	Defective spark plug wires	Replace spark plug wires
	Defective distributor cap, rotor, or coil	Replace cap, rotor, or coil
	Cracked or broken vacuum hoses	Replace vacuum hoses

	Vacuum leaks	Repair vacuum leaks
	Fuel lines clogged	Remove restriction
Hesitation	Cracked or broken vacuum hoses	Replace vacuum hoses
	Vacuum leaks	Repair Vacuum leaks
	Binding carburetor linkage	Eliminate binding
	Binding throttle linkage	Eliminate binding
	Binding choke linkage or fast idle cam	Eliminate binding
	Improper float setting	Readjust float setting, see FUEL
	Cracked or broken ignition wires	Replace ignition wires
Rough idle, Missing or Stalling	Incorrect curb idle or fast idle speed	Reset idle speed, see see ENGINE PERFORMANCE
	Incorrect basic timing	Reset ignition timing see ENGINE PERFORMANCE
	Improper idle mixture adjustment	Reset idle mixture, see ENGINE PERFORMANCE
	Improper feedback system operation	Check feedback system see ENGINE PERFORMANCE
	Incorrect spark plug gap	Reset spark plug gap, see ENGINE PERFORMANCE
	Moisture in ignition components	Dry components
	Loose or broken ignition wires	Replace ignition wires
	Damaged distributor cap or or rotor	Replace distributor cap or rotor
	Faulty ignition coil	Replace ignition coil
	Fuel filter clogged or worn	Replace fuel filter
	Damaged idle mixture screw	Replace idle mixture screw, see FUEL
	Improper fast idle cam adjustment	Reset fast idle cam adjustment, see TUNE- see ENGINE PERFORMANCE
	Improper EGR valve operation	Replace EGR valve
	Faulty PCV valve air flow	Replace PCV valve
	Choke binding or improper choke setting	Reset choke or eliminate binding

	Vacuum leak	Repair vacuum leak
	Improper float bowl fuel level	Reset float adjustment, see FUEL
	Clogged air bleed or idle passages	Clean carburetor passages, see FUEL
	Clogged or worn air cleaner filter	Replace air filter
	Faulty choke vacuum diaphragm	Replace diaphragm, see ENGINE PERFORMANCE
	Exhaust manifold heat valve inoperative	Replace heat valve
	Improper distributor spark advance	Check distributor operation
	Leaking valves or valve components	Check and repair valvetrain
	Improper carburetor mounting	Remove and remount carburetor
	Excessive play in distributor shaft	Replace distributor
	Loose or corroded wiring connections	Repair or replace as required
Engine Surges	Improper PCV valve airflow	Replace PCV valve
	Vacuum leaks	Repair vacuum leaks
	Clogged air bleeds	Remove restriction
	EGR valve malfunction	Replace EGR valve
	Restricted air cleaner filter	Replace air filter
	Cracked or broken vacuum hoses	Replace vacuum hoses
	Cracked or broken ignition wires	Replace ignition wires
	Vacuum advance malfunction	Check unit and replace as necessary
	Defective or fouled spark plugs	Replace spark plugs
Ping or Spark Knock	Incorrect ignition timing	Reset ignition timing see ENGINE PERFORMANCE
	Distributor centrifugal or vacuum advance malfunction	Check operation and replace as necessary
	Carburetor setting too lean	Readjust mixture

		setting, see ENGINE PERFORMANCE
	Vacuum leak	Eliminate vacuum leak
	EGR valve malfunction	Replace EGR valve
Poor Gasoline Mileage	Cracked or broken vacuum hoses	Replace vacuum hoses
	Vacuum leaks	Repair vacuum leaks
	Defective ignition wires	Replace wires
	Incorrect choke setting	Readjust setting, see ENGINE PERFORMANCE
	Defective vacuum advance	Replace vacuum advance
	Defective spark plugs	Replace spark plugs
	Binding carburetor power piston	Eliminate binding
	Dirt in carburetor jets	Clean and/or replace jets
	Incorrect float adjustment	Readjust float setting, see FUEL
	Defective power valve	Replace power valve, see ENGINE PERFORMANCE
	Incorrect idle speed	Readjust idle speed
Engine Stalls	Improper float level	Readjust float level
	Leaking needle valve and seat	Replace needle valve and seat
	Vacuum leaks	Eliminate vacuum leaks

VACUUM PUMP - DIESEL TROUBLE SHOOTING

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NOTE: Diesel engines mechanical diagnosis is the same as gasoline engines for items such as noisy valves, bearings, pistons, etc. The following trouble shooting covers only items pertaining to diesel engines.

VACUUM PUMP (DIESEL) TROUBLE SHOOTING CHART

CONDITION	POSSIBLE CAUSE	CORRECTION

Excessive Noise	Loose pump-to-drive assembly screws	Tighten screws
	Loose tube on pump assembly	Tighten tube
	Valves not functioning properly	Replace valves
Oil Leakage	Loose end plug	Tighten end plug
	Bad seal crimp	Remove and re-crimp seal

MANUAL TRANSMISSION

MANUAL TRANSMISSION TROUBLE SHOOTING

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MANUAL TRANSMISSION/TRANSAXLE TROUBLE SHOOTING

Condition	Possible Cause
Noisy In Forward Gears	.Low gear oil level, .Loose bell housing bolts, .Worn bearings or gears
Clunk On Deceleration (FWD Only)	.Loose engine mounts, .Worn inboard CV joints, .Worn differential pinion shaft, .Side gear hub counterbore in case worn oversize
Gear Clash When Shifting Forward Gears	.Clutch Out Of Adjustment, .Shift linkage damaged or out of adjustment, .Gears or synchronizers damaged, .Low gear oil level
Transmission Noisy When Moving (RWD Only) Quiet In Neutral With Clutch Engaged	.Worn rear outputshaft bearing
Gear Rattle	.Worn bearings, .Wrong gear oil, .Low gear oil, .Worn gears
Steady Ticking At Idle (Increases With RPM)	.Broken tooth on gear
Gear Clash When Shifting Forward Gears	.Worn or broken synchronizers
Loud Whine In Reverse	.Normal condition (1)

Noise When Stepping On Clutch	.Bad release bearing, .Worn pilot bearing
Ticking Or Screeching As Clutch Is Engaged	.Faulty release bearing, .Uneven pressure plate fingers
Click Or Snap When Clutch Is Engaged	.Worn clutch fork, .Worn or broken front bearing retainer
Transmission Shifts Hard	.Clutch not releasing, .Shift mechanism binding, .Clutch installed backwards
Will Not Shift Into One Gear, Shifts Into All Others	.Bent shift fork, .Worn detent balls
Locked Into Gear, Cannot Shift	.Clutch adjustment, .Worn detent balls
Transmission Jumps Out Of Gear	.Pilot bearing worn, .Bent shift fork, .Worn gear teeth or face .Excessive gear train end play .Worn synchronizers .Missing detent ball spring .Shift mechanism worn or out of adjustment .Engine or transmission mount bolts loose or out of adjustment .Transmission not aligned
Shift Lever Rattle	.Worn shift lever or detents .Worn shift forks .Worn synchronizers sleeve
Shift Lever Hops Under Acceleration	.Worn engine or transmission mounts

(1) - Most units use spur cut gears in reverse and are noisy

POWERTRAIN

CLUTCH TROUBLE SHOOTING

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BASIC CLUTCH TROUBLE SHOOTING CHART

CONDITION	POSSIBLE CAUSE	CORRECTION
Chattering or Grabbing	Incorrect clutch adjustment	Adjust clutch
	Oil, grease or glaze on facings	Disassemble and clean or replace
	Loose "U" joint flange	See DRIVE AXLES article
	Worn input shaft spline	Replace input shaft
	Binding pressure plate	Replace pressure plate
	Binding release lever	See CLUTCH article
	Binding clutch disc hub	Replace clutch disc
	Unequal pressure plate contact	Replace worn/misaligned components
	Loose/bent clutch disc	Replace clutch disc
	Incorrect transmission alignment	Realign transmission
	Worn pressure plate, disc or flywheel	Replace damaged components
	Broken or weak pressure springs	Replace pressure plate
	Sticking clutch pedal	Lubricate clutch pedal & linkage
	Incorrect clutch disc facing	Replace clutch disc
	Engine loose in chassis	Tighten all mounting bolts
Failure to Release	Oil or grease on clutch facings	Clean or replace clutch clutch disc
	Incorrect release lever or pedal adjustment	See CLUTCH article
	Worn or broken clutch facings	Replace clutch disc
	Bent clutch disc or pressure plate	Replace damaged components
	Clutch disc hub binding on input shaft	Clean or replace clutch disc and/or input shaft
	Binding pilot bearing	Replace pilot bearing
	Sticking release bearing sleeve	Replace release bearing and/or sleeve
	Binding clutch cable	See CLUTCH article

	Defective clutch master	Replace master cylinder
	Defective clutch slave	Replace slave cylinder
	Air in hydraulic system	Bleed hydraulic system
Rattling	Weak or broken release lever spring	Replace spring and check alignment
	Damaged pressure plate	Replace pressure plate
	Broken clutch return spring	Replace return spring
	Worn splines on clutch disc or input shaft	Replace clutch disc and/or input shaft
	Worn clutch release bearing	Replace release bearing
	Dry or worn pilot bearing	Lubricate or replace pilot bearing
	Unequal release lever contact	Align or replace release lever
	Incorrect pedal free play	Adjust free play
	Warped or damaged clutch disc	Replace damaged components
Slipping	Pressure springs worn or	Release pressure plate
	Oily, greasy or worn facings	Clean or replace clutch disc
	Incorrect clutch alignment	Realign clutch assembly
	Warped clutch disc or pressure plate	Replace damaged components
	Binding release levers or clutch pedal	Lubricate and/or replace release components
Squeaking	Worn or damaged release	Replace release bearing
	Dry or worn pilot or release bearing	Lubricate or replace assembly
	Pilot bearing turning in crankshaft	Replace pilot bearing and/or crankshaft
	Worn input shaft bearing	Replace bearing and seal
	Incorrect transmission alignment	Realign transmission
	Dry release fork between pivot	Lubricate release fork and pivot
Heavy and/or Stiff Pedal	Sticking release bearing sleeve	Replace release bearing and/or sleeve

	Dry or binding clutch pedal hub	Lubricate and align components
	Floor mat interference with pedal	Lay mat flat in proper area
	Dry or binding ball/fork pivots	Lubricate and align components
	Faulty clutch cable	Replace clutch cable
Noisy Clutch Pedal	Faulty interlock switch	Replace interlock switch
	Self-adjuster ratchet noise	Lubricate or replace self-adjuster
	Speed control interlock switch	Lubricate or replace interlock switch
Clutch Pedal Sticks Down	Binding clutch cable	See CLUTCH article
	Springs weak in pressure plate	Replace pressure plate
	Binding in clutch linkage	Lubricate and free linkage
Noisy	Dry release bearing	Lubricate or replace release bearing
	Dry or worn pilot bearing	Lubricate or replace bearing
	Worn input shaft bearing	Replace bearing
Transmission Click	Weak springs in pressure plate	Replace pressure plate
	Release fork loose on ball stud	Replace release fork and/or ball stud
	Oil on clutch disc damper	Replace clutch disc
	Broken spring in slave cylinder	Replace slave cylinder

DRIVE AXLE - NOISE DIAGNOSIS

Unrelated Noises

Some driveline trouble symptoms are also common to the engine, transmission, wheel bearings, tires, and other parts of the vehicle. Ensure cause of trouble actually is in the drive axle before adjusting, repairing, or replacing any of its parts.

Non-Drive Axle Noises

A few conditions can sound just like drive axle noise and have to be considered in pre-diagnosis. The 4 most common noises are exhaust, tires, CV/universal joints and wheel trim rings.

In certain conditions, the pitch of the exhaust gases may sound like gear whine. At other times, it may be mistaken for a wheel bearing rumble.

Tires, especially radial and snow, can have a high-pitched tread whine or roar, similar to gear noise. Also, some non-standard tires with an unusual tread construction may emit a roar or whine.

Defective CV/universal joints may cause clicking noises or excessive driveline play that can be improperly diagnosed as drive axle problems.

Trim and moldings also can cause a whistling or whining noise. Ensure none of these components are causing the noise before disassembling the drive axle.

Gear Noise

A "howling" or "whining" noise from the ring and pinion gear can be caused by an improper gear pattern, gear damage, or improper bearing preload. It can occur at various speeds and driving conditions, or it can be continuous.

Before disassembling axle to diagnose and correct gear noise, make sure that tires, exhaust, and vehicle trim have been checked as possible causes.

Chuckle

This is a particular rattling noise that sounds like a stick against the spokes of a spinning bicycle wheel. It occurs while decelerating from 40 MPH and usually can be heard until vehicle comes to a complete stop. The frequency varies with the speed of the vehicle.

A chuckle that occurs on the driving phase is usually caused by excessive clearance due to differential gear wear, or by a damaged tooth on the coast side of the pinion or ring gear. Even a very small tooth nick or a ridge on the edge of a gear tooth is enough the cause the noise.

This condition can be corrected simply by cleaning the gear tooth nick or ridge with a small grinding wheel. If either gear is damaged or scored badly, the gear set must be replaced. If metal has broken loose, the carrier and housing must be cleaned to remove particles that could cause damage.

Knock

This is very similar to a chuckle, though it may be louder, and occur on acceleration or deceleration. Knock can be caused by a gear tooth that is damaged on the drive side of the ring and pinion gears. Ring gear bolts that are hitting the carrier casting can cause knock. Knock can also be due to excessive end play in the axle shafts.

Clunk

Clunk is a metallic noise heard when an automatic transmission is engaged in Reverse or Drive, or when throttle is applied or released. It is caused by backlash somewhere in the driveline, but not necessarily in the axle. To determine whether driveline clunk is caused by the axle, check the total axle backlash as follows:

1) Raise vehicle on a frame or twinpost hoist so that drive wheels are free. Clamp a bar between axle companion flange and a part of the frame or body so that flange cannot move.

2) On conventional drive axles, lock the left wheel to keep it from turning. On all models, turn the right wheel slowly until it is felt to be in Drive condition. Hold a chalk marker on side of tire about 12" from center of wheel. Turn wheel in the opposite direction until it is again felt to be in Drive condition.

3) Measure the length of the chalk mark, which is the total

axle backlash. If backlash is one inch or less, drive axle is not the source of clunk noise.

Bearing Whine

Bearing whine is a high-pitched sound similar to a whistle. It is usually caused by malfunctioning pinion bearings. Pinion bearings operate at drive shaft speed. Roller wheel bearings may whine in a similar manner if they run completely dry of lubricant. Bearing noise will occur at all driving speeds. This distinguishes it from gear whine, which usually comes and goes as speed changes.

Bearing Rumble

Bearing rumble sounds like marbles being tumbled. It is usually caused by a malfunctioning wheel bearing. The lower pitch is because the wheel bearing turns at only about 1/3 of drive shaft speed.

Chatter On Turns

This is a condition where the entire front or rear of vehicle vibrates when vehicle is moving. The vibration is plainly felt as well as heard. Extra differential thrust washers installed during axle repair can cause a condition of partial lock-up that creates this chatter.

Axle Shaft Noise

Axle shaft noise is similar to gear noise and pinion bearing whine. Axle shaft bearing noise will normally distinguish itself from gear noise by occurring in all driving modes (Drive, cruise, coast and float), and will persist with transmission in Neutral while vehicle is moving at problem speed.

If vehicle displays this noise condition, remove suspect axle shafts, replace wheel seals and install a new set of bearings. Re-evaluate vehicle for noise before removing any internal components.

Vibration

Vibration is a high-frequency trembling, shaking or grinding condition (felt or heard) that may be constant or variable in level and can occur during the total operating speed range of the vehicle.

The types of vibrations that can be felt in the vehicle can be divided into 3 main groups:

* Vibrations of various unbalanced rotating parts of the vehicle.
* Resonance vibrations of the body and frame structures caused by rotating of unbalanced parts.
* Tip-in moans of resonance vibrations from stressed engine or exhaust system mounts or driveline flexing modes.

DRIVE AXLE - RWD TROUBLE SHOOTING

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DRIVE AXLE (RWD) TROUBLE SHOOTING

CONDITION	POSSIBLE CAUSE	CORRECTION

Knocking or Clunking		
	Differential Side Gear Clearance	Check Clearance
	Worn Pinion Shaft	Replace Pinion Shaft
	Axle Shaft End Play	Check End Play
	Missing Gear Teeth	Check Differential/ Replace Gear
	Wrong Axle Backlash	Check Backlash
	Misaligned Driveline	Realign Driveline
Clinking During Engagement		
	Side Gear Clearance	Check Clearance
	Ring and Pinion Backlash	Check Backlash
	Worn/Loose Pinion Shaft	Replace Shaft/Bearing
	Bad "U" Joint	Replace "U" Joint
	Sticking Slip Yoke	Lube Slip Yoke
	Broken Rear Axle Mount	Replace Mount
	Loose Drive Shaft Flange	Check Flange
Click/Chatter On Turns		
	Differential Side Gear Clearance	Check Clearance
	Wrong Turn On Plates (1)	Replace Clutch Plates
	Wrong Differential Lubricant (1)	Change Lubricant
Knock Or Click	Flat Spot on Rear Wheel Bearing	Replace Wheel Bearing
Low Vibration At All Speeds		
	Faulty Wheel Bearing	Replace Wheel Bearing
	Faulty "U" Joint	Replace "U" Joint
	Faulty Drive Shaft	Balance Drive Shaft
	Faulty Companion Flange	Replace Flange
	Faulty Slip Yoke Flange	Replace Flange

(1) - Limited slip differential only.

FWD AXLE SHAFTS & CV JOINTS TROUBLE SHOOTING

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problem symptoms. For model-specific Trouble Shooting, refer to SUBJECT, DIAGNOSTIC, or TESTING articles available in the section(s) you are accessing.

BASIC FWD AXLE SHAFTS & CV JOINTS TROUBLE SHOOTING CHART

CONDITION	POSSIBLE CAUSE
Grease Leaks	CV boot torn or cracked
Clicking Noise on Cornering	Damaged outer CV
Clunk Noise on Acceleration	Damaged inner CV
Vibration or Shudder on Acceleration	Sticking, damaged or worn CV Misalignment or spring height

STEERING & SUSPENSION

MANUAL STEERING GEAR TROUBLE SHOOTING

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BASIC MANUAL STEERING GEAR TROUBLE SHOOTING CHART

CONDITION	POSSIBLE CAUSE	CORRECTION
Rattle or Chucking Noise in Rack and Pinion	Rack and pinion mounting bracket loose	Tighten all mounting bolts
	Lack of/or incorrect lubricant	Correct as necessary
	Steering gear mounting bolts loose	Tighten all mounting bolts
Excessive Play	Front wheel bearing improperly adjusted	See FRONT SUSPENSION article
	Loose or worn steering linkage	See STEERING LINKAGE article
	Loose or worn steering gear shift	See MANUAL STEERING GEAR article
	Steering arm loose on gear shaft	See MANUAL STEERING GEAR article
	Steering gear housing bolts loose	Tighten all mounting bolts
	Steering gear adjustment too loose	See MANUAL STEERING GEAR article
	Steering arms loose on	Tighten and check

	knuckles	steering linkage
	Rack and pinion mounting loose	Tighten all mounting bolts
	Rack and pinion out of adjustment	See adjustment in STEERING article
	Tie rod end loose	Tighten and check steering linkage
	Excessive Pitman shaft-to-ball nut lash	Repair as necessary
Poor Returnability	Lack of lubricant in ball joint or linkage	Lubricate and service systems
	Binding in linkage or ball joints	See STEERING LINKAGE and SUSPENSION article
	Improper front end alignment	See WHEEL ALIGNMENT article
	Improper tire pressure	Inflate to proper pressure
	Tie rod binding	Inflate to proper pressure
	Shaft seal rubbing shaft	See STEERING COLUMN article
Excessive Vertical Motion	Improper tire pressure	Inflate to proper pressure
	Tires, wheels or rotors out of balance	Balance tires then check wheels and rotors
	Worn or faulty shock absorbers	Check and replace if necessary
	Loose tie rod ends or steering	Tighten or replace if necessary
	Loose or worn wheel bearings	See SUSPENSION article
Steering Pulls to One Side	Improper tire pressure	Inflate to proper pressure
	Front tires are different sizes	Rotate or replace if necessary
	Wheel bearings not adjusted properly	See FRONT SUSPENSION article
	Bent or broken suspension components	See FRONT SUSPENSION article
	Improper wheel alignment	See WHEEL ALIGNMENT article

	Brakes dragging	See BRAKES article
Instability	Low or uneven tire pressure	Inflate to proper pressure
	Loose or worn wheel bearings	See FRONT SUSPENSION article
	Loose or worn idler arm bushing	See FRONT SUSPENSION article
	Loose or worn strut bushings	See FRONT SUSPENSION article
	Incorrect front wheel alignment	See WHEEL ALIGNMENT article
	Steering gear not centered	See MANUAL STEERING GEARS article
	Springs or shock	Check and replace if necessary
	Improper cross shaft	See MANUAL STEERING GEARS article

POWER STEERING TROUBLE SHOOTING

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BASIC POWER STEERING TROUBLE SHOOTING CHART

CONDITION	POSSIBLE CAUSE	CORRECTION
Rattle or Chucking Noise	Pressure hoses touching engine parts	Adjust to proper clearance
	Loose Pitman shaft	Adjust or replace if necessary
	Tie rods ends or Pitman arm loose	Tighten and check system
	Rack and pinion mounts loose	Tighten all mounting bolts
	Free play in worm and	See POWER STEERING GEAR article
	Loose sector shaft or thrust bearing adjustment	See POWER STEERING GEAR
	Free play in pot coupling	See STEERING COLUMN article

	Worn shaft serrations	See STEERING COLUMN article
Growl in Steering Pump	Excessive pressure in hoses	Restricted hoses, see POWER STEERING GEAR article
	Scored pressure plates	See POWER STEERING GEAR article
	Scored thrust plates or rotor	See POWER STEERING GEAR article
	Extreme wear of cam ring	See POWER STEERING GEAR article
Rattle in Steering Pump	Vanes not installed	See POWER STEERING PUMP article
	Vanes sticking in rotor	See POWER STEERING PUMP article
Swish noise in Pump	Defective flow control valve	See POWER STEERING PUMP article
Groan in Steering Pump	Air in fluid	See POWER STEERING PUMP article
	Poor pressure hose connection	Tighten and check, replace if necessary
Squawk When Turning	Damper "O" ring on valve spool cut	See POWER STEERING PUMP article
Moan or Whine in Pump	Pump shaft bearing scored	Replace bearing and fluid
	Air in fluid or fluid level low	See POWER STEERING PUMP article
	Hose or column grounded	Check and replace if necessary
	Cover "O" ring missing or damaged	See POWER STEERING PUMP article
	Valve cover baffle missing or damaged	See POWER STEERING PUMP article
	Interference of components in pump	See POWER STEERING PUMP article
	Loose or poor bracket alignment	Correct or replace if necessary
Hissing When Parking	Internal leakage in steering gear	Check valved assembly first
Chirp in Steering Pump	Loose or worn power steering belt	Adjust or replace if necessary
Buzzing When Not Steering	Noisy pump	See POWER STEERING PUMP article

	Free play in steering shaft bearing	See STEERING COLUMN article
	Bearing loose on shaft serrations	See STEERING COLUMN article
Clicking Noise in Pump	Pump slippers too long	See POWER STEERING PUMP article
	Broken slipper springs	See POWER STEERING PUMP article
	Excessive wear or nicked rotors	See POWER STEERING PUMP article
	Damaged cam contour	See POWER STEERING PUMP article
Poor Return of Wheel	Wheel rubbing against turn signal	See STEERING COLUMN SWITCHES article
	Flange rubbing steering gear adjuster	See STEERING COLUMN article
	Tight or frozen steering shaft bearing	See STEERING COLUMN article
	Steering gear out of adjustment	See POWER STEERING GEAR article
	Sticking or plugged spool valve	See POWER STEERING PUMP article
	Improper front end alignment	See WHEEL ALIGNMENT article
	Wheel bearings worn or loose	See FRONT SUSPENSION article
	Ties rods or ball joints binding	Check and replace if necessary
	Intermediate shaft joints binding	See STEERING COLUMN article
	Kinked pressure hoses	Correct or replace if necessary
	Loose housing head spanner nut	See POWER STEERING GEAR article
	Damaged valve lever	See POWER STEERING GEAR article
	Sector shaft adjusted too tight	See ADJUSTMENTS in POWER STEERING GEAR article
	Worm thrust bearing adjusted too tight	See ADJUSTMENTS in POWER STEERING GEAR article
	Reaction ring sticking in cylinder	See POWER STEERING GEAR article

	Reaction ring sticking in housing head	See POWER STEERING GEAR article
	Steering pump internal leakage	See POWER STEERING PUMP article
	Steering gear-to-column misalignment	See STEERING COLUMN article
	Lack of lubrication in linkage	Service front suspension
	Lack of lubrication in ball joints	Service front suspension
Increased Effort When Turning Wheel Fast Foaming, Milky Power Steering Fluid, Low Fluid Level or Low Pressure	High internal pump leakage	See POWER STEERING PUMP article
	Power steering pump belt slipping	Adjust or replace if necessary
	Low fluid level	Check and fill to proper level
	Engine idle speed to low	Adjust to correct setting
	Air in pump fluid system	See POWER STEERING PUMP article
	Pump output low	See POWER STEERING PUMP article
	Steering gear malfunctioning	See POWER STEERING GEAR article
Wheel Surges or Jerks	Low fluid level	Check and fill to proper level
	Loose fan belt	Adjust or replace if necessary
	Insufficient pump pressure	See POWER STEERING PUMP article
	Sticky flow control valve	See POWER STEERING PUMP article
	Linkage hitting oil pan at full turn	Replace bent components
Kick Back or Free Play	Air in pump fluid system	See POWER STEERING PUMP article
	Worn poppet valve in steering gear	See POWER STEERING PUMP article
	Excessive over center lash	See POWER STEERING GEAR article
	Thrust bearing out of adjustment	See POWER STEERING GEAR article

	Free play in pot coupling	See POWER STEERING PUMP article
	Steering gear coupling loose on shaft	See POWER STEERING PUMP article
	Steering disc mounting bolts loose	Tighten or replace if necessary
	Coupling loose on worm shaft	Tighten or replace if necessary
	Improper sector shaft adjustment	See POWER STEERING GEAR article
	Excessive worm piston side play	See POWER STEERING GEAR article
	Damaged valve lever	See POWER STEERING GEAR article
	Universal joint loose	Tighten or replace if necessary
	Defective rotary valve	See POWER STEERING GEAR article
No Power When Parking	Sticking flow control valve	See POWER STEERING PUMP article
	Insufficient pump pressure output	See POWER STEERING PUMP article
	Excessive internal pump leakage	See POWER STEERING PUMP article
	Excessive internal gear leakage	See POWER STEERING PUMP article
	Flange rubs against gear adjust plug	See STEERING COLUMN article
	Loose pump belt	Adjust or replace if necessary
	Low fluid level	Check and add proper amount of fluid
	Engine idle too low	Adjust to correct setting
	Steering gear-to-column misaligned	See STEERING COLUMN article
No Power, Left Turn	Left turn reaction seal "O" ring worn	See POWER STEERING GEAR article
	Left turn reaction seal damaged/missing	See POWER STEERING GEAR article
	Cylinder head "O" ring damaged	See POWER STEERING PUMP article

No Power, Right Turns	Column pot coupling bottomed	See STEERING COLUMN article
	Right turn reaction seal "O" ring worn	See POWER STEERING GEAR article
	Right turn reaction seal damaged	See POWER STEERING GEAR article
	Internal leakage through piston end plug	See POWER STEERING GEAR article
	Internal leakage through side plugs	See POWER STEERING GEAR article
Lack of Effort in Turning	Left and/or right reaction seal sticking in cylinder head	Replace, see POWER STEERING GEAR article
Wanders to One Side	Front end alignment incorrect	See WHEEL ALIGNMENT article
	Unbalanced steering gear valve	See POWER STEERING GEAR article
Low Pressure Due to Steering Pump	Flow control valve stuck or inoperative	See POWER STEERING PUMP article
	Pressure plate not flat against cam ring	See POWER STEERING PUMP article
	Extreme wear of cam ring	Replace and check adjustments
	Scored plate, thrust plate or rotor	See POWER STEERING PUMP article
	Vanes not installed properly	See POWER STEERING PUMP article
	Vanes sticking in rotor slots	See POWER STEERING PUMP article
	Cracked/broken thrust or pressure plate	See POWER STEERING PUMP article

STEERING COLUMN TROUBLE SHOOTING

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BASIC STEERING COLUMN TROUBLE SHOOTING CHART

CONDITION	POSSIBLE CAUSE	CORRECTION
Noise in Steering	Coupling pulled apart	See STEERING COLUMNS article

	Column not correctly aligned	See STEERING COLUMNS article
	Broken lower joint	Replace joint
	Horn contact ring not	See STEERING COLUMN article
	Bearing not lubricated	See STEERING COLUMN article
	Shaft snap ring not properly seated	Reseat or replace snap ring
	Plastic spherical joint not lubricated	See STEERING COLUMN article
	Shroud or housing loose	Tighten holding screws
	Lock plate retaining ring not seated	See STEERING COLUMN article
	Loose sight shield	Tighten holding screws
High Steering Shaft Effort	Column assembly misaligned	See STEERING COLUMN article
	Improperly installed dust shield	Adjust or replace
	Tight steering universal joint	See STEERING COLUMN article
High Shift Effort	Column is out of alignment	See STEERING COLUMN article
	Improperly installed dust shield	Adjust or replace
	Seals or bearings not lubricated	See STEERING COLUMNS article
	Mounting bracket screws too long	Replace with new shorter screws
	Burrs on shift tube	Remove burrs or replace tube
	Lower bowl bearing assembled wrong	See STEERING COLUMN article
	Shift tube bent or broken	Replace as necessary
	Improper adjustment of shift levers	See STEERING COLUMN article
Improper Trans. Shifting	Sheared shift tube joint	Replace as necessary
	Sheared lower shaft lever	Replace as necessary
	Improper shift lever adjustment	See STEERING COLUMN article

	Improper gate plate adjustment	See STEERING COLUMN article
Excess Play in Column	Instrument panel bracket bolts loose	Tighten bolts and check bracket
	Broken weld nut on jacket	See STEERING COLUMN article
	Instrument bracket capsule sheared	See STEERING COLUMN article
	Column bracket/jacket bolts loose	Tighten bolts and check bracket
Steering Locks in Gear	Release lever mechanism	See STEERING COLUMN article

SUSPENSION TROUBLE SHOOTING

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BASIC SUSPENSION TROUBLE SHOOTING CHART

CONDITION	POSSIBLE CAUSE	CORRECTION
Front End Noise	Loose or worn wheel	See Wheel Bearing Adjustment in SUSPENSION
	Worn shocks or shock mountings	Replace struts or strut mountings
	Worn struts or strut mountings	Replace struts or strut mountings
	Loose or worn lower control arm	See SUSPENSION
	Loose steering gear-to-frame bolts	See STEERING
	Worn control arm bushings	See SUSPENSION
	Ball joints not lubricated	Lubricate ball joints & see Ball Joint Checking in SUSPENSION
Front Wheel Shake, Shimmy, or Vibration	Tires or wheels out of balance	Check tire balance
	Incorrect wheel alignment	See WHEEL ALIGNMENT
	Drive shaft unbalanced	Check drive shaft balance

	Loose or worn wheel bearings	See WHEEL ALIGNMENT
	Loose or worn tie rod ends	See SUSPENSION
	Worn upper ball joints	See Ball Joint Checking in SUSPENSION
	Worn shock absorbers	Replace shock absorbers
	Worn strut bushings	Replace strut bushings
Car Pulls to One Side	Mismatched or uneven tires	Check tire condition
	Broken or sagging springs	See SUSPENSION
	Loose or worn strut bushings	See SUSPENSION
	Improper wheel alignment	See WHEEL ALIGNMENT
	Improper rear axle alignment	Check rear axle alignment
	Power steering gear unbalanced	See STEERING
	Front brakes dragging	See BRAKES
Abnormal Tire Wear	Unbalanced tires	Check tire balance & rotation
	Sagging or broken springs	See SUSPENSION
	Incorrect front end alignment	See WHEEL ALIGNMENT
	Faulty shock absorbers	Replace chock absorbers
Scuffed Tires	Toe-In incorrect	See WHEEL ALIGNMENT
	Suspension arm bent or twisted	See appropriate SUSPENSION article
Springs Bottom or Sag	Bent or broken springs	See SUSPENSION
	Leaking or worn shock absorbers	Replace shock absorbers
	Frame misalignment	Check frame for damage
Spring Noises	Loose "U" Bolts	See SUSPENSION
	Loose or worn bushings	See SUSPENSION
	Worn or missing interliners	See SUSPENSION
Shock Absorber Noise	Loose shock mountings	Check & tighten mountings
	Worn bushings	Replace bushings

	Air in system	Bleed air from system
	Undercoating on shocks	Remove undercoating
Car Leans or Sways on Corners	Loose stabilizer bar	See SUSPENSION
	Faulty shocks or mountings	Replace shocks or mountings
	Broken or sagging springs	See SUSPENSION
Shock Absorbers Leaking	Worn seals or reservoir tube crimped	See SUSPENSION
Broken Springs	Loose "U" bolts	See SUSPENSION
	Inoperative shock absorbers	Replace shock absorbers

WHEEL ALIGNMENT TROUBLE SHOOTING

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BASIC WHEEL ALIGNMENT TROUBLE SHOOTING CHART

CONDITION	POSSIBLE CAUSE	CORRECTION
Premature Tire Wear	Improper tire inflation	Check tire pressure
	Front alignment out of tolerance	See ALIGNMENT SPECS in WHEEL ALIGNMENT section
	Suspension components worn	See SUSPENSION section
	Steering system components worn	See STEERING section
	Improper standing height	See WHEEL ALIGNMENT
	Uneven or sagging springs	See SUSPENSION section
	Bent wheel	See WHEEL ALIGNMENT
	Improper torsion bar adjustment	See SUSPENSION section
	Loose or worn wheel bearings	See WHEEL BEARING ADJ. in SUSPENSION section
	Worn or defective shock	Replace shock absorbers
	Tires out of balance	Check tire balance
Pulls to One Side	Improper tire inflation	Check tire pressure
	Brake dragging	See BRAKE section

	Mismatched tires	See WHEEL ALIGNMENT
	Broken or sagging spring	See SUSPENSION section
	Broken torsion bar	See SUSPENSION section
	Power steering valve not centered	See STEERING section
	Front alignment out of tolerance	See WHEEL ALIGNMENT section
	Defective wheel bearing	See WHEEL BEARINGS in SUSPENSION section
	Uneven sway bar links	See SUSPENSION section
	Frame bent	Check for frame damage
	Steering system bushing worn	See STEERING section
Hard Steering	Idler arm bushing too tight	See STEERING LINKAGE in STEERING section
	Ball joint tight or seized	See SUSPENSION section
	Steering linkage too tight	See STEERING LINKAGE in STEERING section
	Power steering fluid low	Add proper amount of fluid
	Power steering drive belt loose	See STEERING section
	Power steering pump defective	See STEERING section
	Steering gear out of adjustment	See STEERING section
	Incorrect wheel alignment	See WHEEL ALIGNMENT
	Damaged steering gear	See STEERING section
	Damaged suspension	See SUSPENSION section
	Bent steering knuckle or supports	See SUSPENSION section
Vehicle "Wanders"	Strut rod or control arm bushing worn	See SUSPENSION section
	Loose or worn wheel bearings	See WHEEL BEARINGS in SUSPENSION section
	Improper tire inflation	Check tire pressure
	Stabilizer bar missing or defective	See SUSPENSION section

	Wheel alignment out of tolerance	See Adjustment in WHEEL ALIGNMENT section
	Broken spring	See SUSPENSION section
	Defective shock absorbers	Replace shock absorbers
	Worn steering & suspension components	See SUSPENSION section
Front End Shimmy	Tire out of balance/round	Check tire balance
	Excessive wheel runout	See WHEEL ALIGNMENT
	Insufficient or improper caster	See WHEEL ALIGNMENT section
	Worn suspension or steering components	See SUSPENSION section
	Defective shock absorbers	Replace shock absorber
	Wheel bearings worn or loose	See WHEEL BEARING ADJ. in SUSPENSION section
	Power steering reaction Bracket loose	See STEERING section
	Steering gear box (rack) mounting loose	See STEERING section
	Steering gear adjustment loose	See STEERING section
	Worn spherical joints	See SUSPENSION section
Toe-In Not Adjustable	Lower control arm bent	See SUSPENSION section
	Frame bent	Check frame for damage
Camber Not Adjustable	Control arm bent	See SUSPENSION section
	Frame bent	Check frame for damage
	Hub & bearing not seated properly	See SUSPENSION section

1988 Jeep 4 Tune-Up
TUNE-UP

All Models

IDENTIFICATION

ENGINE IDENTIFICATION

Engine can be identified by the 4th character of the Vehicle Identification Number (VIN). The VIN is stamped on a plate attached to top left corner of instrument panel.

ENGINE CODES

Engine	Code
2.5L (150") TBI	H

TUNE-UP NOTES

NOTE: When performing tune-up procedures described in this article, the following notes and precautions must be followed.

Due to late changes and corrections, always refer to Emission Control Label in engine compartment before attempting tune-up. If manual and label differ, always use label specifications.

EPA High Altitude emission standards apply to vehicles sold in certain areas outside California which have an elevation above 4000 feet.

When performing tune-up on vehicles equipped with catalytic converter, do not allow or create an engine misfire in one or more cylinders for an extended period of time. Damage to converter may occur due to loading converter with unburned fuel.

TESTING

ENGINE COMPRESSION

Test compression with all spark plugs removed, throttle plates and choke valve wide open and engine at normal operating temperature. Crank engine through at least 5 compression strokes before recording reading.

COMPRESSION SPECIFICATIONS

Application	Specification
Compression Ratio	9.2:1
Compression Pressure	155-185 psi (10.9-13.0 kg/cm^2)
Max. Variation Between Cylinders	30 psi (2.1 kg/cm^2)

SPARK PLUGS

SPARK PLUG TYPE

Application	Champion No.
2.5L	RC-12LYC

SPARK PLUG SPECIFICATIONS

Application	Gap: In. (mm)	Torque: Ft. Lbs. (N.m)
2.5L	.035 (.89)	7-15 (9-20)

HIGH TENSION WIRE RESISTANCE

Do not puncture spark plug wires with any type of probe. Remove spark plug wire and check resistance with an ohmmeter.

ADJUSTMENTS

VALVE ARRANGEMENT

* E-I-I-E-E-I-I-E (Front-to-rear).

VALVE CLEARANCE

All models are equipped with hydraulic lifters, which should be adjusted to zero lash.

IGNITION COIL WIRE

Remove ignition coil wire from coil and distributor cap. Check terminals for corrosion and clean if necessary. Check coil wire resistance. Replace wire if resistance is excessive.

HIGH TENSION WIRE RESISTANCE (OHMS)

Wire Length (In.)	Minimum	Maximum
0-15	3000	10,000
15-25	4000	15,000
25-35	6000	20,000
Over 35	8000	25,000

DISTRIBUTOR

All models are equipped with a Renix solid state ignition module. Renix system uses a TDC sensor mounted near the flywheel. The distributor consists of a cap and rotor. Its only function is to distribute high voltage to appropriate spark plug. No adjustments are required on either system.

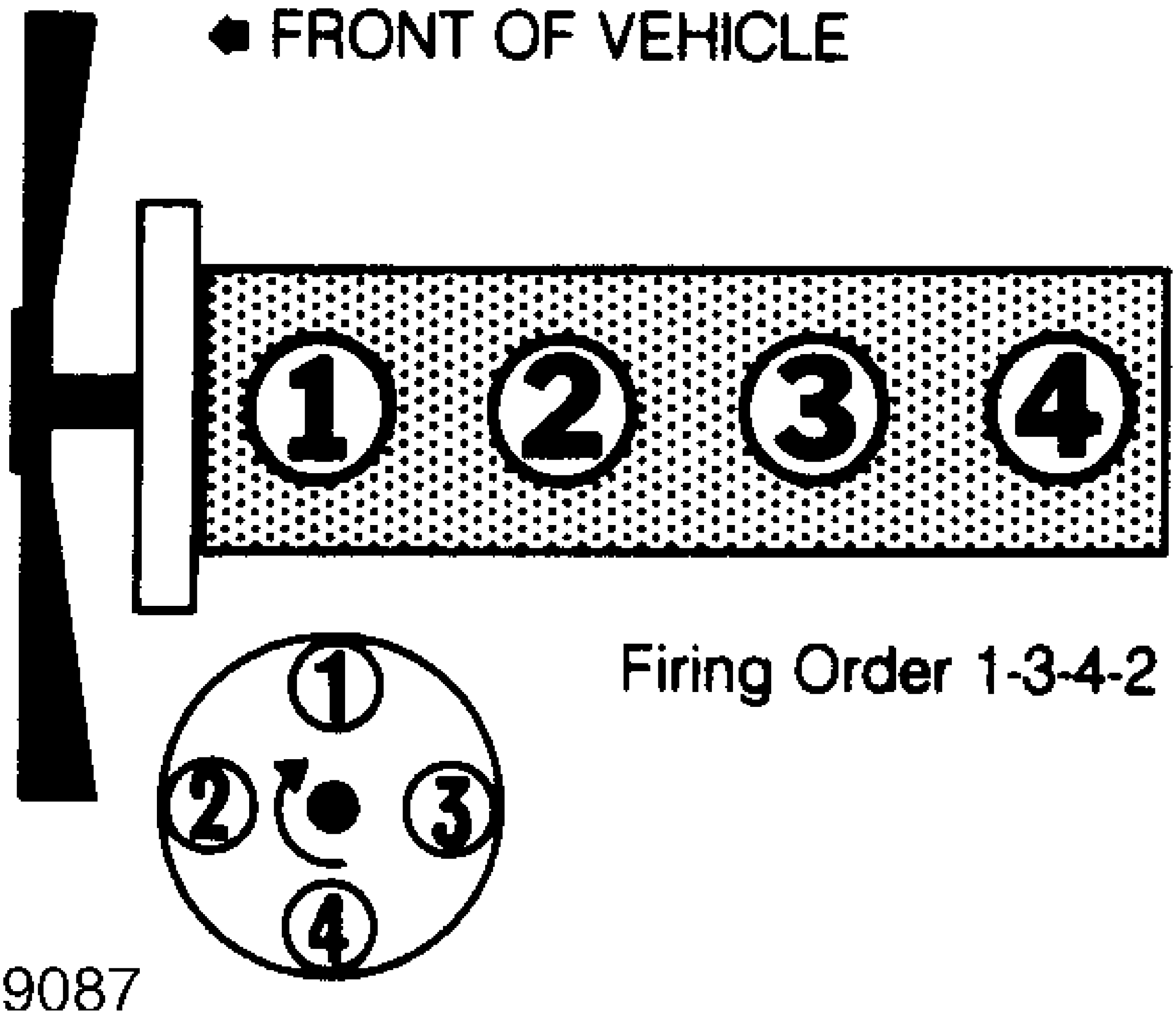

Fig. 1: 2.5L Firing Order & Distributor Rotation

IGNITION TIMING

NOTE: No adjustment is possible on models with Renix ignition.

HOT (SLOW) IDLE RPM

NOTE: Adjust ISC motor plunger only after replacing ISC motor.

Idle Speed Control (ISC) Motor Plunger

1) Remove air cleaner, turn off A/C (if equipped) and warm engine to normal operating temperature. Connect tachometer negative lead to diagnostic connector terminal "D1-3" and positive lead to connector terminal "D1-1". See Fig. 2. Turn ignition off. ISC plunger should fully extend.

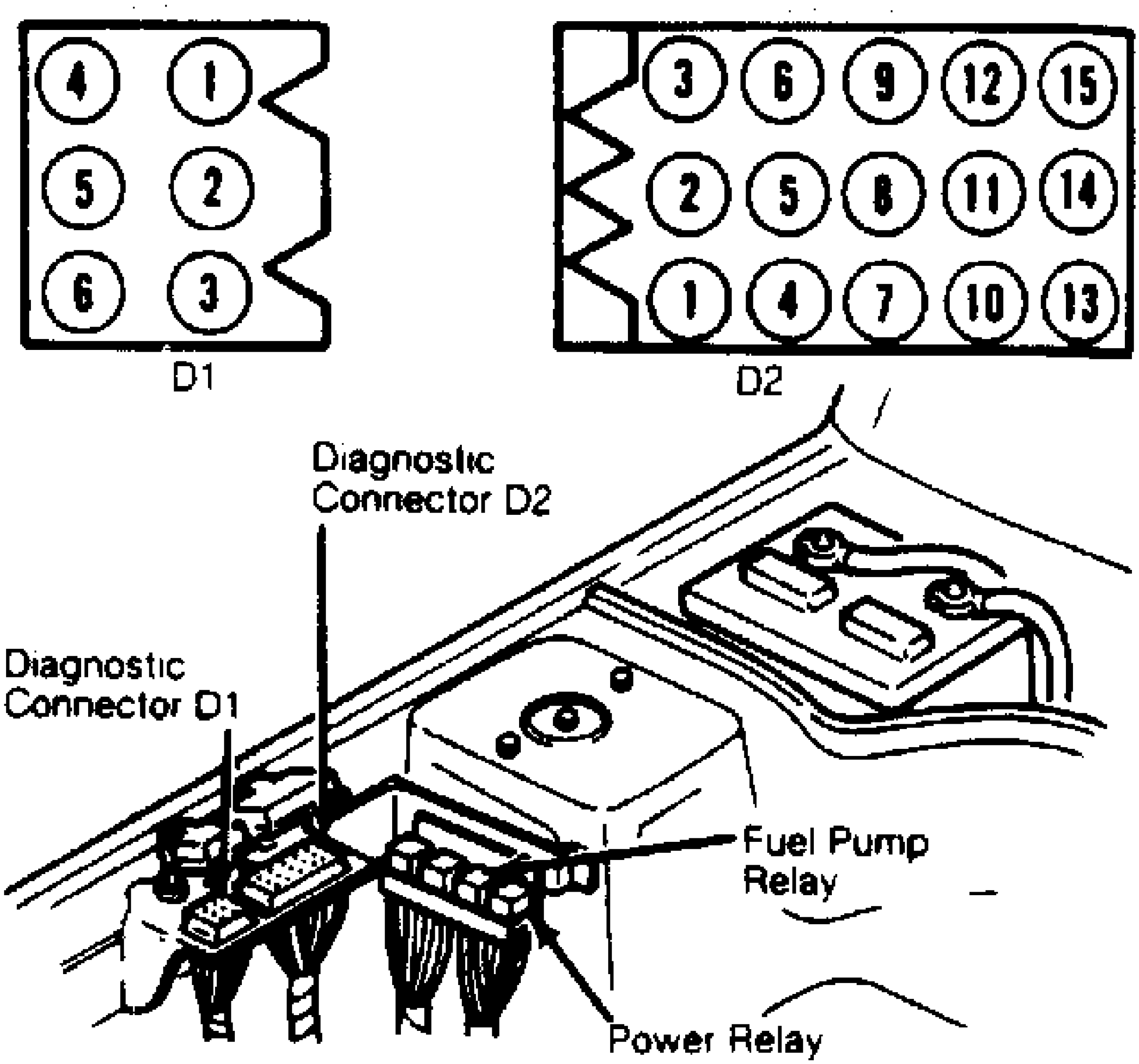

Fig. 2: TBI Diagnostic Connector & Terminal ID
Courtesy of Chrysler Motors.

2) With plunger extended, disconnect ISC motor electrical connector. Start engine. Engine idle speed should be 3300-3700 RPM. If not, turn plunger hex head to obtain 3500 RPM. See Fig. 3.

3) To fully retract ISC motor, hold closed throttle switch plunger inward while opening throttle. Closed throttle switch plunger should not touch throttle lever when throttle is closed. If this occurs, check linkage and/or cable for binding.

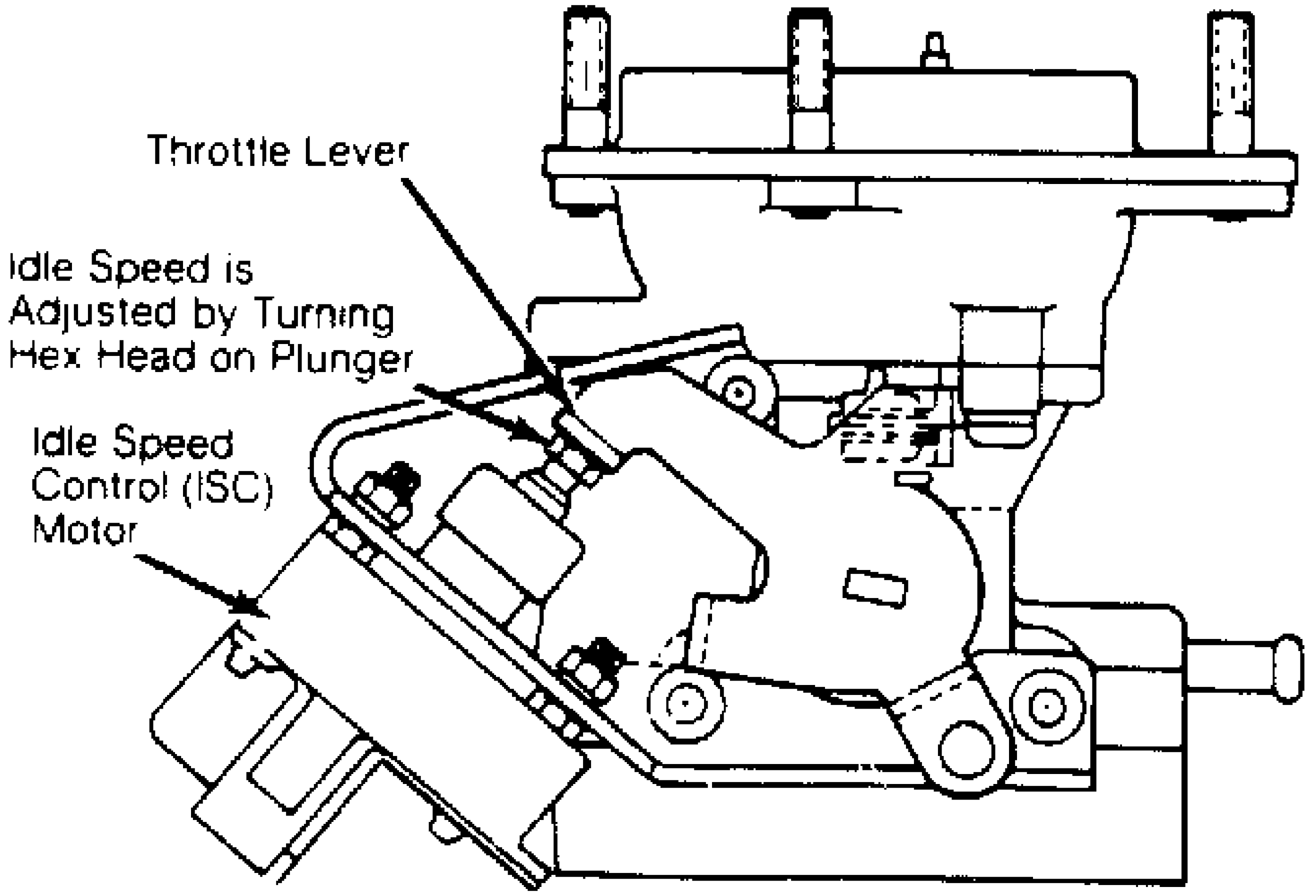

Fig. 3: TBI Idle Speed Control (ISC) Motor Adjustment
Courtesy of Chrysler Motors.

4) Connect ISC motor connector. Turn ignition off for 10 seconds. ISC motor should fully extend. Restart engine. Engine speed should momentarily be about 3500 RPM and return to idle speed. Turn ignition off and disconnect tachometer. Apply sealant to adjustment screw threads. Install air cleaner.

IDLE SPEED (RPM)

Application	Curb Idle
2.5L TBI (ISC Plunger Extended)	3500

NOTE: Holding plunger inward may create an intermittent trouble code in ECU memory. To clear ECU memory, turn ignition off and disconnect negative battery cable for 10 seconds.

THROTTLE POSITION SENSOR (TPS) ADJUSTMENT

NOTE: On some models, it may be necessary to remove throttle body from intake manifold, to access sensor wiring harness.

Automatic Transmission

1) Locate the square TPS connector. Note connector terminal identification stamped on the back of the connector. Turn ignition on.

2) Connect voltmeter through back of wiring harness

connector. Connect negative voltmeter lead to terminal "D" and positive voltmeter lead to terminal "A" to check input voltage. DO NOT disconnect TPS connector.

3) Hold throttle plate closed against idle stop and note voltage. Input voltage should be approximately 5 volts. Disconnect voltmeter positive lead and connect to terminal "B" to measure output voltage.

4) With throttle plate closed, measure the output voltage. The output voltage should be approximately .2 volts. If output voltage is not within specification, loosen TPS retaining screws.

5) Partially tighten one retaining screw. Rotate TPS to obtain correct output voltage. Tighten retaining screws once correct voltage is obtained.

Manual Transmission

1) Turn ignition on. Connect voltmeter through back of wiring harness connector. Connect negative voltmeter lead to terminal "B" and positive voltmeter lead to terminal "C". DO NOT disconnect TPS connector. See Fig. 4.

2) Rotate and hold throttle plate in wide open position. Ensure throttle linkage contacts stop. Note voltmeter reading. Voltage reading should be 5 volts at wide open throttle. Return throttle plate to closed throttle position. Disconnect voltmeter positive lead from sensor terminal "C" and connect it to terminal "A".

3) Rotate and hold throttle plate in wide open position. Ensure throttle linkage contacts stop. Note voltmeter reading. Output voltage should be 4.6-4.7 volts. If voltage is not as specified, loosen sensor mounting screw. Loosen upper sensor mounting screw for small adjustments and lower screw for large adjustments.

4) Adjust sensor. Tighten sensor mounting screws. Remove voltmeter and return throttle plate to closed position. Replace sensor if specified output voltage cannot be obtained.

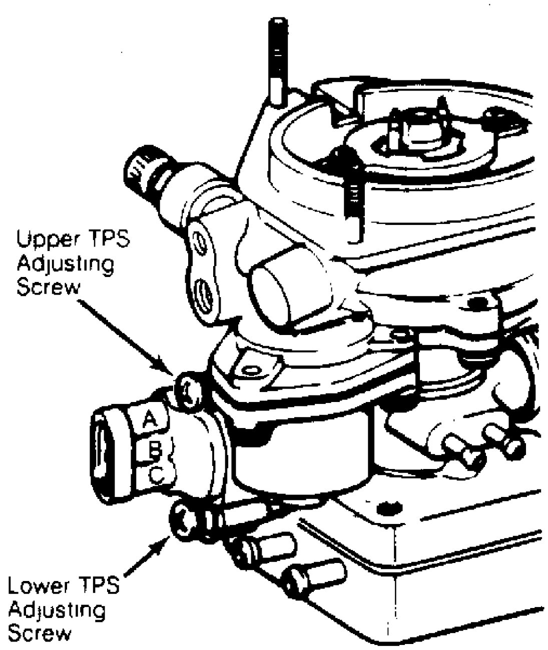

Fig. 4: Adjusting Throttle Position Sensor (Man Trans)
Courtesy of Chrysler Motors.

IDLE MIXTURE ADJUSTMENT

NOTE: Idle mixture adjustment is not possible on TBI models.

COLD (FAST) IDLE RPM

NOTE: Fast idle is not adjustable on TBI models.

SERVICING

EMISSION CONTROL

See EMISSIONS section.

SPECIFICATIONS

IGNITION

Distributor
All models are equipped with Renix solid state ignition.

IGNITION COIL RESISTANCE - OHMS @ 75°F (24°C)

Application	Primary	Secondary
2.5L	.4-.8	2500-4000

FUEL SYSTEM

FUEL INJECTION

Application	Model
2.5L	Renix TBI

Fuel Pump
The 2.5L engine with TBI uses an electric fuel pump located in the tank.

FUEL PUMP SPECIFICATIONS

Application	Pressure: psi (kg/cm²)	Volume: Pts. (L)
2.5L (TBI)	14.5 (1.0)	N/A

BATTERY

BATTERY SPECIFICATIONS

Application **	Cold Cranking (1) Amps	Reserve Capacity Minutes
Standard	421	75
Optional	452	81

(1) - At 0°F (-18°C).

STARTER

All 2.5L engines use a Bosch positive engagement starter.

STARTER SPECIFICATIONS

Application	Volts	Amps	Test RPM
2.5L	12	75	2900

ALTERNATOR

All 2.5L engines use a Delco-Remy 10SI or 12SI alternator with integral regulator.

ALTERNATOR SPECIFICATIONS

Application **	Field Current Draw @ 12 Volts	Rated Amp Output
Standard	4.0-5.0 Amps	56
Optional	4.0-5.0 Amps	66
Optional	4.0-5.0 Amps	78

ALTERNATOR REGULATOR

All 2.5L models use Delco-Remy nonadjustable regulators, integral with alternator.

REGULATOR OPERATING VOLTAGE @ 80°F (27°C)

Application	Voltage
2.5L	13.9-14.9

BELT ADJUSTMENT

BELT ADJUSTMENT - TENSION IN LBS. (KG) USING STRAND TENSION GAUGE

Application	New Belt	Used Belt
"V" Belts (1)	125-155 (57-70)	90-115 (41-52)
Serpentine	180-200 (82-91)	140-150 (64-68)

(1) - Adjust new P/S belt to 120-140 lbs. (54-64 kg).

SERVICE INTERVALS

REPLACEMENT INTERVALS

Component	Interval (Miles)
Air Filter	30,000
Fuel Filter	30,000
Engine Oil & Filter	7500
PCV Valve	30,000
Spark Plugs	30,000

CAPACITIES

FLUID CAPACITIES

Application	Quantity
Auto. Trans. (Dexron II)	
Wrangler	8.0 qts. (7.6L)
All Others	8.5 qts. (8.0L)
Cooling System	
Wrangler	9.0 qts. (8.5L)
All Others	10.0 qts. (9.5L)
Crankcase (Includes Filter)	4.0 qts. (3.8L)
Drive Axle	
Front	2.5 pts. (1.2L)
Rear	
Commanche	
Standard Capacity	2.5 pts. (1.2L)
Metric Ton Axle	4.8 pts. (2.3L)
All Others	2.5 pts. (1.2L)
Fuel Tank	
Cherokee & Wagoneer	
Standard	13.5 gals. (51L)
Optional	20 gals. (76L)
Comanche	
Standard	16 gals. (60L)
Optional	23.5 gals. (89L)
Wrangler	
Standard	15 gals. (57L)
Optional	20 gals. (75L)
Manual Transmission	
AX4	7.8 pts. (3.7L)
AX5	7.4 pts. (3.5L)
BA 10/5	3.5 pts. (1.6L)
Transfer Case (Dexron II)	
Wrangler	3.25 pts. (1.5L)
All Others	
Command Trac	2.2 pts. (1.0L)
Select Trac	3.0 pts. (1.4L)

SYSTEM REFRIGERANT CAPACITIES

Application	Ozs.
All Models	36

1987-88 TUNE-UP
Jeep 6 Cylinder Tune-Up

Cherokee, Comanche, Wagoneer, Wrangler

IDENTIFICATION

ENGINE IDENTIFICATION

Engine can be identified by the fourth character of engine Build Date Code number, located on a tag attached to right side of block between No. 2 and 3 cylinders.

The same code letter is also the fourth character in the Vehicle Identification Number (VIN), located at top left corner of dashboard.

ENGINE CODE TABLE

Engine	Code
4.0L (242") MPFI	M
4.2L (258") 2-Bbl.	C

TUNE-UP NOTES

NOTE: When performing tune-up procedures described in this article, these notes and precautions must be followed.

Due to late changes and corrections, always refer to Emission Control Label in engine compartment before attempting tune-up. If manual and label specifications differ, use label specifications.

When performing tune-up on vehicles equipped with a catalytic converter, do not allow or create an engine misfire in one or more cylinders for an extended period of time. Damage to converter from overheating may occur due to loading with unburned fuel.

TESTING

ENGINE COMPRESSION

Check compression pressure with engine at normal operating temperature, all spark plugs removed, throttle and choke valves wide open and engine at cranking speed.

COMPRESSION SPECIFICATIONS TABLE

Application	Specification
Compression Ratio	9.2:1
Compression Pressure	120-150 psi (8.4-10.5 kg/cm^2)
Maximum Variation Between Cylinders	30 psi (2.1 kg/cm^2)

HIGH TENSION WIRE RESISTANCE

Do not puncture spark plug wires with any type of probe. Remove spark plug wire and check resistance using an ohmmeter.

SPARK PLUGS

SPARK PLUG TYPE TABLE

Application	Champion No.
All Models	RFN14LY

SPARK PLUG SPECIFICATIONS TABLE

Gap: In. (mm)	Torque: Ft. Lbs. (N.m)
0.035 (0.89)	7-15 (10-20)

FUEL PUMP

4.0L

1) Remove the cap from the pressure test port located in the fuel rail. See Fig. 1. Connect Fuel Pressure Gauge (J-34730-1) to the pressure fitting.

2) Start vehicle. Pressure should be approximately 31 psi (2.1 kg/cm²) with the vacuum hose connected to the pressure regulator and 39 psi (2.6 kg/cm²) with the vacuum hose removed from the pressure regulator. See FUEL PUMP SPECIFICATIONS TABLE.

3) Check the fuel pump flow rate. A good fuel pump will deliver at least one liter of fuel per minute with the fuel return line pinched off. If the fuel pump does not pump adequately, inspect the fuel system for a plugged fuel filter or filter sock.

4) Fuel pump flow rate can be checked by connecting one end of an old A/C gauge hose to the fuel test port on the fuel rail and inserting the other end of the hose into a container of at least one liter or more capacity.

5) Run the fuel pump by installing a jumper wire into diagnostic connector terminals D1-5 and D1-6. Be sure to pinch off the fuel return line or most of the fuel will be returned to the fuel tank.

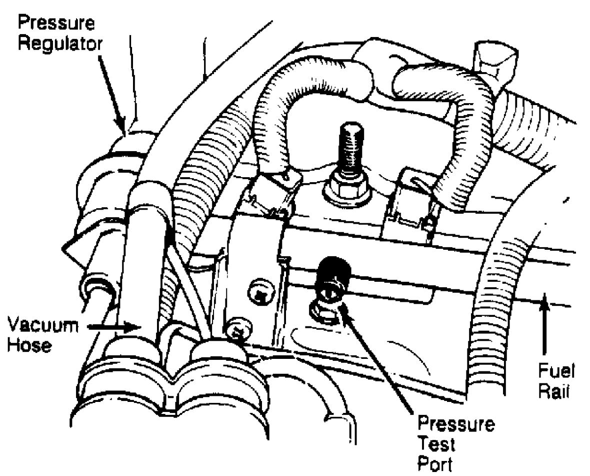

Fig. 1: Fuel System Pressure Test Components
Courtesy of American Motors/Jeep Corp.

4.2L

Perform fuel pump test with air cleaner removed and fuel

inlet line or filter disconnected at carburetor. Disconnect fuel return line at fuel filter and plug nipple on filter. Make all tests at idle speed. See FUEL PUMP SPECIFICATIONS TABLE.

FUEL PUMP SPECIFICATIONS TABLE

Application **	Pressure psi (kg/cm^2)	Volume (1) Pts. (L)
4.0L	(2) 31 (2.1)	1.0 (.47)
4.0L	(3) 39 (2.6)	1.0 (.47)
4.2L	4.0-5.0 (.28-.35)	1.0 (.47)

(1) - Volume per 30 seconds.
(2) - With the vacuum hose connected to the pressure regulator.
(3) - With the vacuum hose removed from the pressure regulator.

ADJUSTMENTS

VALVE ARRANGEMENT

* E-I-I-E-I-E-E-I-E-I-I-E (Front-to-rear).

VALVE CLEARANCE

All engines are equipped with hydraulic lifters. Valve clearance is not adjustable.

IGNITION COIL WIRE

Remove ignition coil wire from coil and distributor cap. Check terminals for corrosion and clean (if necessary). Check coil wire resistance. Replace wire if resistance is excessive.

HIGH TENSION WIRE RESISTANCE (OHMS) TABLE

Wire Length	Minimum	Maximum
0-15"	3000	10,000
15-25"	4000	15,000
25-35"	6000	20,000
Over 35"	8000	25,000

DISTRIBUTOR

4.0L
Information not available from manufacturer.

4.2L
All models are equipped with Motorcraft Solid State Ignition (SSI) systems. No adjustments are required.

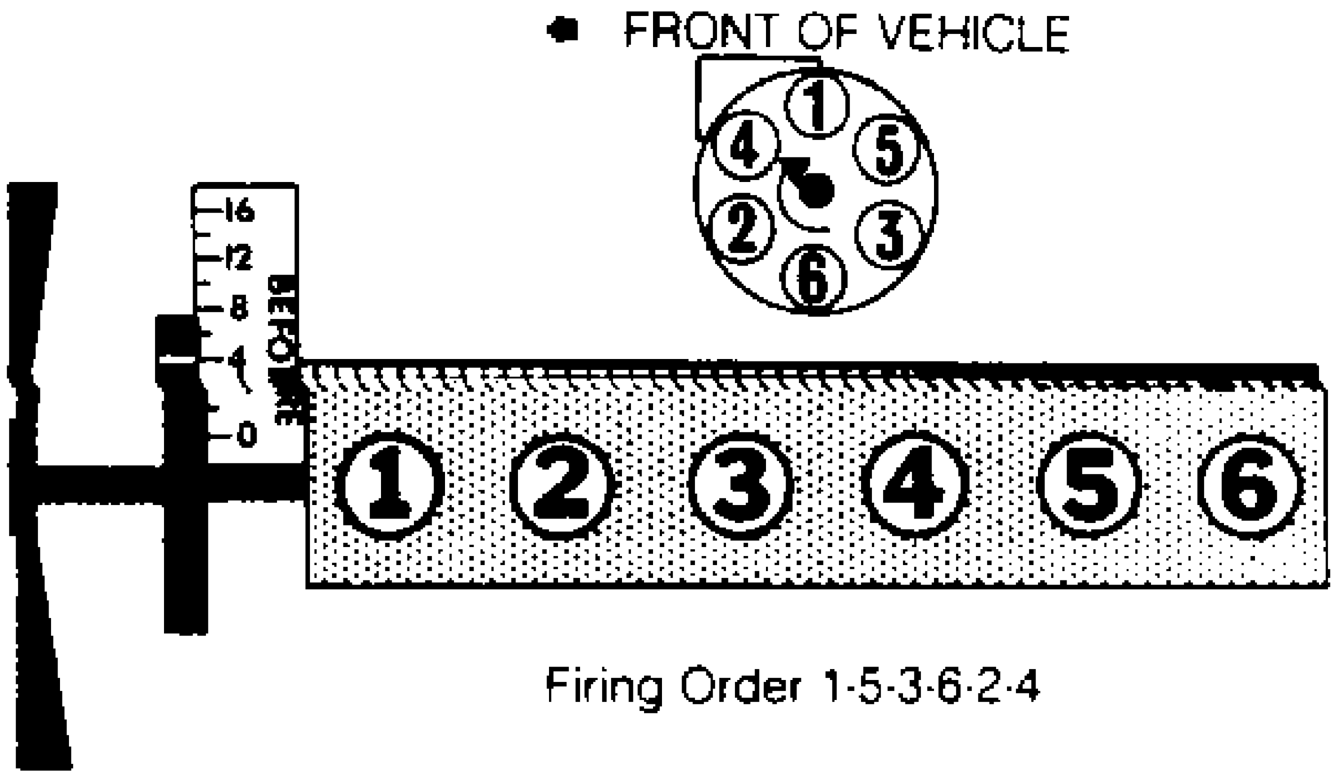

Fig. 2: 4.0L & 4.2L Timing Marks & Firing Order
Magnetic probe located at 9.5 degrees ATDC on 4.2L.

IGNITION TIMING (4.0L)

Information not available from manufacturer.

IGNITION TIMING (4.2L)

NOTE: Engines are equipped with a receptacle for a magnetic probe timing light, located 9.5 degrees ATDC. Do not use this location to check timing with a conventional light, use a magnetic probe timing light.

Standard Timing Procedure

1) Apply parking brake, and place transmission in Neutral (Park for automatic transmissions). Operate engine to normal operating temperature. Turn ignition off. Install timing light.

2) Connect tachometer. Disconnect and plug vacuum hose at distributor. Disconnect vacuum switch assembly wire connector, located on top of valve cover. Start engine and increase engine speed to 1600 RPM.

3) Compare timing to specification. See IGNITION TIMING SPECIFICATIONS table. To adjust timing, loosen distributor clamp bolt and turn distributor. Recheck timing after clamp bolt is tightened.

Alternate Timing Procedure

1) Apply parking brake and place transmission in Neutral (Drive for automatic transmissions). Operate engine to obtain normal operating temperature. Turn ignition off. Install timing light.

2) Disconnect and plug vacuum switch hose (Red and Black

wires connected to switch). Disconnect distributor vacuum advance hose and connect hose to vacuum switch. Disconnect wire connector from knock sensor, located in cylinder head.

3) Using a jumper wire, ground knock sensor wire connector to engine block. Start engine. With engine at idle speed (solenoid energized), check timing. Adjust timing to one degree more than specification (if required). See Emission Control Label.

IGNITION TIMING SPECIFICATIONS (DEGREES BTDC@RPM) - 4.2L

Application	Man. Trans.	Auto. Trans.
50 State	9 @ 1600	9 @ 1600
High Altitude	16 @ 1600	16 @ 1600

HOT (SLOW) IDLE RPM

4.0L

1) Apply parking brake and place transmission in Neutral (Drive for automatic transmissions). Operate engine to normal operating temperature. Turn ignition off.

2) Ensure all accessories are off. Connect positive tachometer lead to terminal "D1-1" and negative lead to "D2-7" of diagnostic connectors. See Fig. 3. Disconnect air stepper motor connector and TPS wiring connector. See Fig. 4.

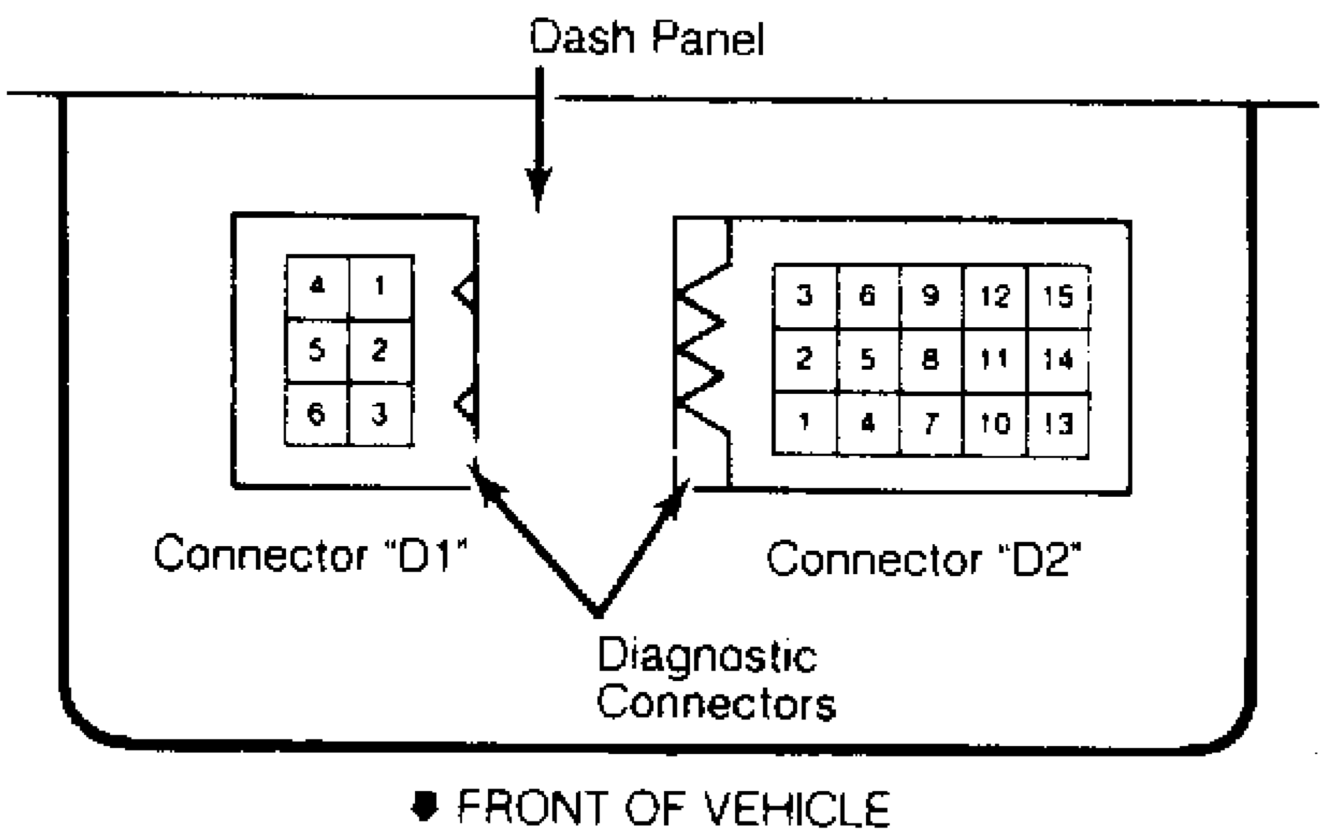

Fig. 3: Diagnostic Connector Terminal Identification
Courtesy of Chrysler Motors.

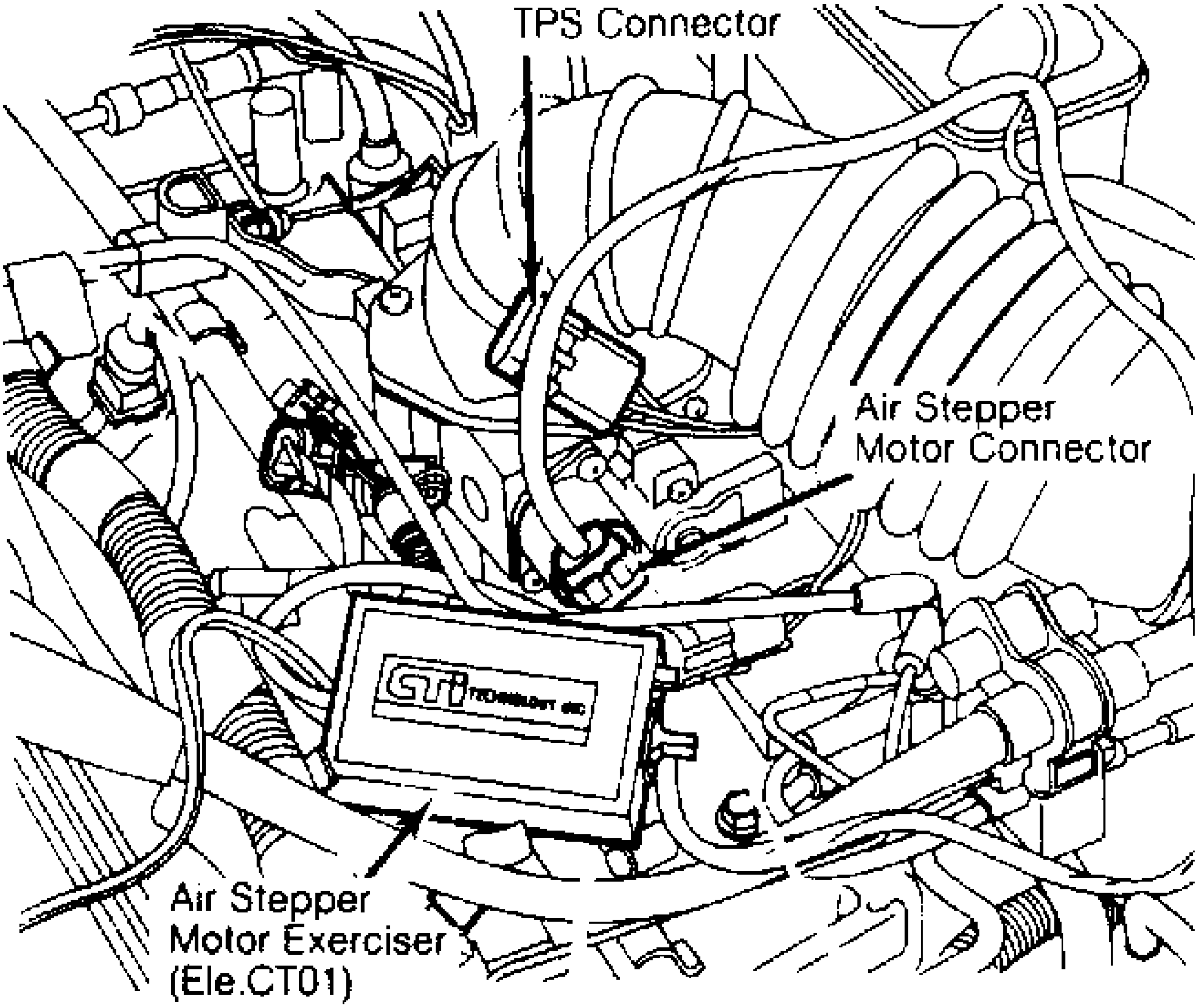

Fig. 4: Installing Air Stepper Motor Exerciser
Courtesy of Chrysler Motors.

3) Install Air Stepper Motor Exerciser (Ele.CT01) on the air stepper motor connector. See Fig. 4. Install the Red terminal of the air stepper exerciser on the positive battery post and the Black terminal on the negative battery terminal.

4) Start engine and place stepper motor exerciser switch on the "LOW" position and note engine RPM. Idle speed should be 750F50 RPM. Disconnect and remove air stepper motor exerciser.

5) If adjustment is required, turn ignition off. Remove the welch plug from the RPM adjusting screw cavity. See Fig. 5. Turn RPM adjusting screw inward 2 turns. Start the engine and note engine RPM.

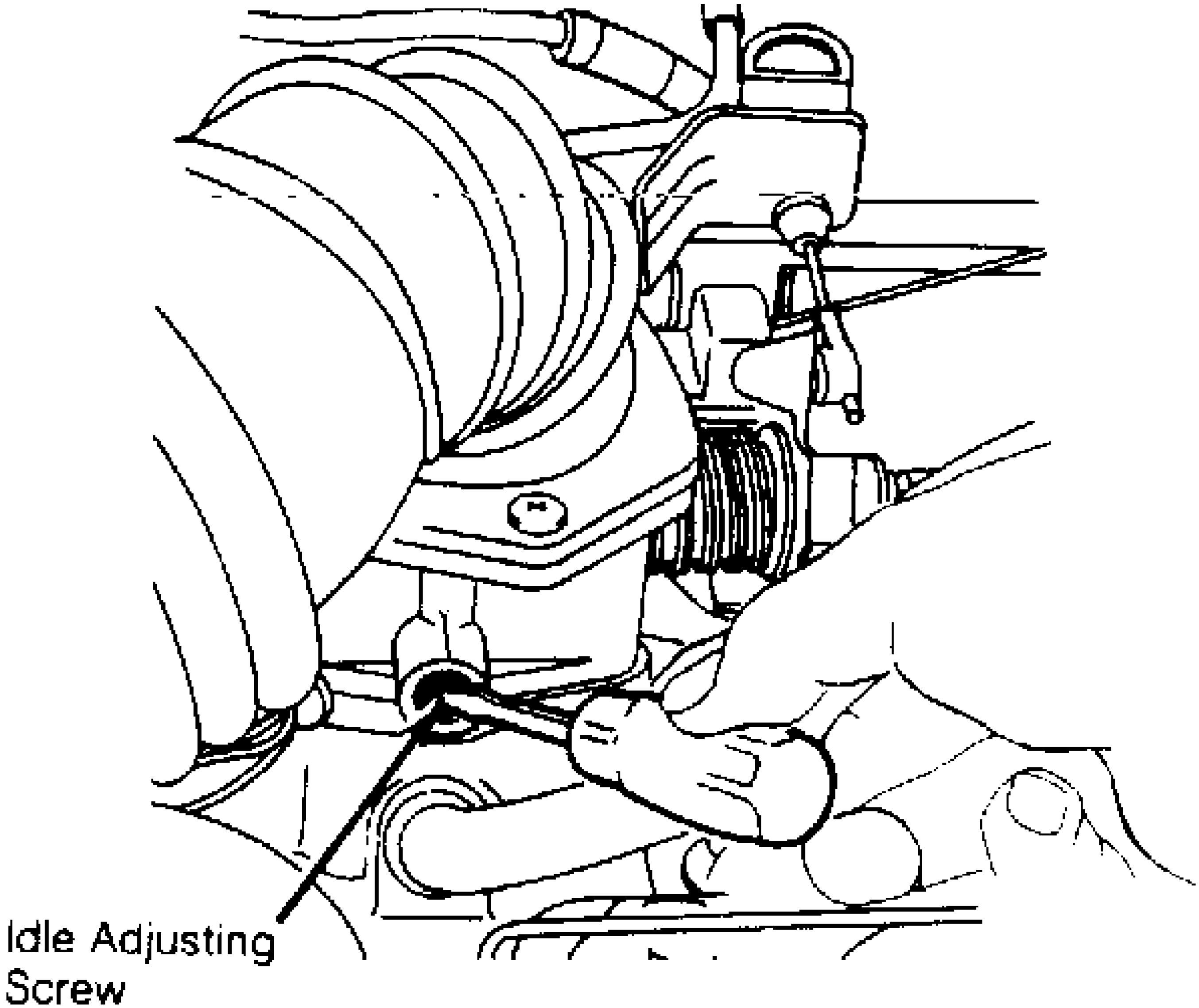

Fig. 5: Adjusting Idle RPM
Courtesy of Chrysler Motors.

6) Adjust idle RPM screw to obtain idle speed of 750F50 RPM. Once correct idle RPM is obtained, seal the welch plug cavity with RTV sealant. Reconnect air stepper motor and TPS.

4.2L

1) Warm engine to normal operating temperature. Apply parking brake. Place automatic transmission in Drive (Neutral on manual transmission). Disconnect and plug vacuum hose from vacuum actuator. Disconnect solenoid wire connector.

2) Adjust curb idle screw to obtain correct curb idle. See CURB IDLE SPEED (RPM) table. Apply 10-15 in. Hg vacuum to vacuum actuator. With throttle positioner fully extended, adjust screw on throttle lever, to set vacuum actuator RPM to specification. See VACUUM ACTUATOR & SOLENOID IDLE (RPM) table. Disconnect vacuum pump.

3) Apply battery voltage to solenoid with a jumper wire. Turn A/C on (if equipped). Open throttle, allowing solenoid to fully extend. Adjust solenoid adjusting screw to obtain solenoid idle RPM.

See VACUUM ACTUATOR & SOLENOID IDLE (RPM) table. Reconnect solenoid connector and vacuum hose.

CURB IDLE SPEED (RPM) TABLE - 4.2L

Application	Man. Trans.	Auto. Trans.
50 State	680	600
High Altitude	700	650

VACUUM ACTUATOR & SOLENOID IDLE (RPM) TABLE - 4.2L

Application	Vacuum Actuator	Solenoid Energized
Man. Trans.	1100	900
Auto. Trans.	900	800

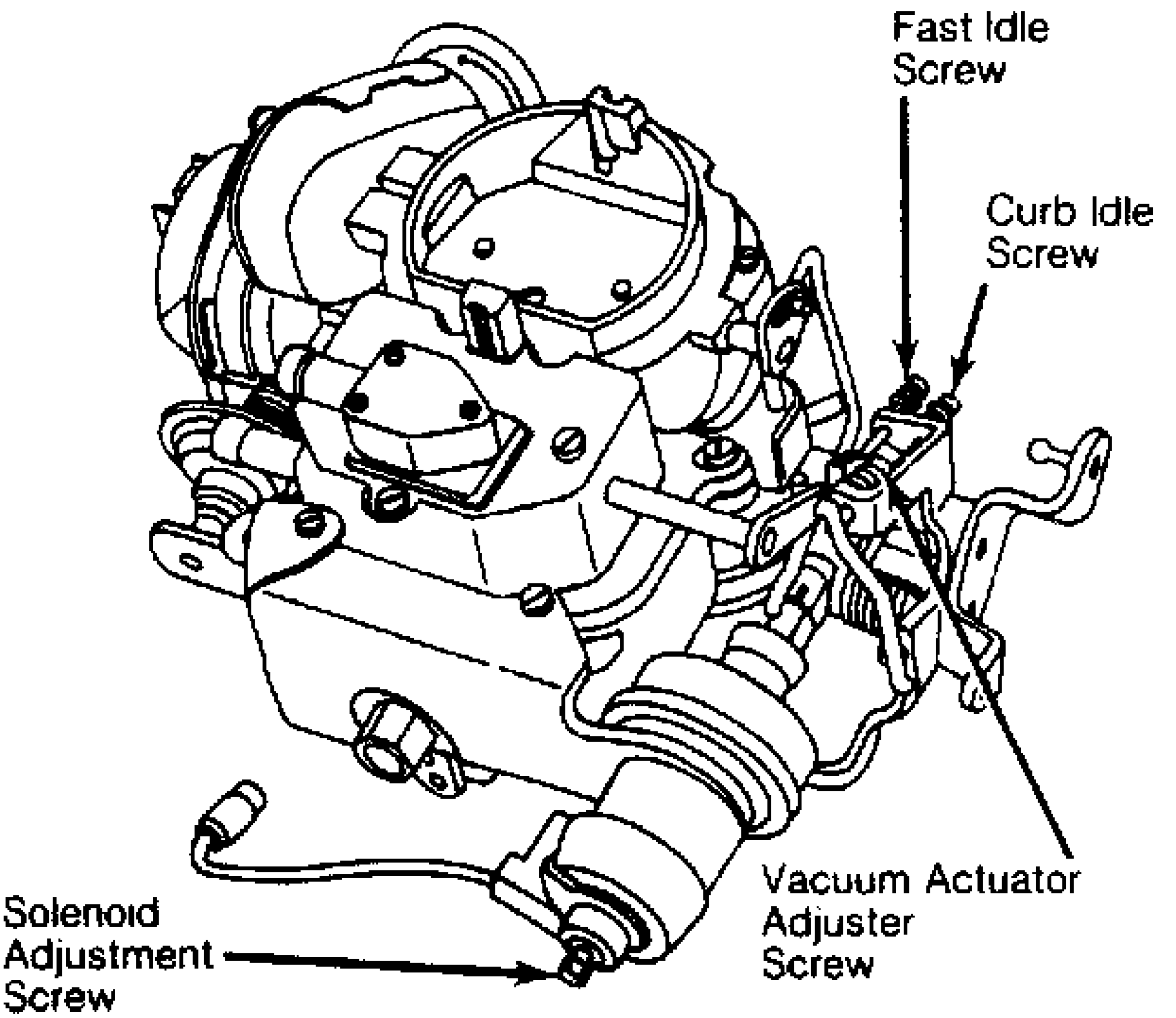

Fig. 6: Adjusting 4.2L Idle RPM
Courtesy of Chrysler Motors.

NOTE: Idle mixture adjustment is not part of a normal tune-up. DO NOT adjust mixture unless carburetor has been disassembled

or vehicle fails emissions testing.

IDLE MIXTURE (TACHOMETER (LEAN DROP) PROCEDURE)

NOTE: On 4.2L engines, ensure idle speed and timing are set prior to adjusting the idle mixture. If mixture adjustment time exceeds 3 minutes, run engine at 2000 RPM in Neutral for one minute, and resume adjustment. On 4.0L engines, idle mixture adjustment is not possible.

4.2L

1) Remove carburetor and locate roll pins blocking idle mixture screws. Drill through throttle body on closed end of roll pin hole. Drive pins out with punch. Reinstall carburetor. Install tachometer.

2) Operate engine to normal operating temperature, and adjust curb idle speed. Place automatic transmission selector in Drive (Neutral for manual transmissions). Turn mixture screws inward until RPM drops. Turn screws outward until highest RPM is reached.

3) Turn mixture screws inward to obtain the correct decrease in RPM. See LEAN DROP (RPM) table. Adjust both screws equally. When mixture is correctly adjusted, replace roll pin to block adjustment screws.

NOTE: If final RPM differs more than 30 RPM from specified curb idle speed, reset curb idle, and repeat mixture adjustment.

LEAN DROP (RPM) TABLE

Application	Man. Trans.	Auto. Trans.
4.2L	50	50

THROTTLE POSITION SENSOR (TPS)

NOTE: Adjustment of TPS only applies to the 4.0L models. It may be necessary to remove throttle body from intake manifold, to access sensor wiring harness.

Checking & Adjusting - 4.0L (Automatic Transmission)

1) Locate the square TPS connector. Note connector terminal identification stamped on the back of the connector. Turn ignition on.

2) Connect voltmeter through back of wiring harness connector. Connect negative voltmeter lead to terminal "D" and positive voltmeter lead to terminal "A" to check input voltage. DO NOT disconnect TPS connector.

3) Hold throttle plate closed against idle stop and note voltage. Input voltage should be approximately 5 volts. Disconnect voltmeter positive lead and connect to terminal "B" to measure output voltage.

4) With throttle plate closed, measure the output voltage. The output voltage should be approximately 4.2 volts. If output voltage is not within specification, loosen TPS retaining screws.

5) Partially tighten one retaining screw. Rotate TPS to obtain correct output voltage. Tighten retaining screws once correct voltage is obtained.

Checking & Adjusting - 4.0L (Manual Transmission)

1) Turn ignition on. Connect voltmeter through back of wiring harness connector. Connect negative voltmeter lead to terminal "B" and positive voltmeter lead to terminal "A". DO NOT disconnect TPS connector.

2) Hold throttle plate in the closed throttle position against idle stop and note input voltage reading. Input voltage should be approximately 5.0 volts.

3) Disconnect positive lead from terminal "A" and connect to terminal "C" to check output voltage. Output voltage should be checked with throttle plates fully closed.

4) Output voltage should be approximately 0.8 volts. If output voltage is not within specification, loosen TPS bottom retaining screw and pivot sensor for a large adjustment or top retaining screw for a fine adjustment.

5) Adjust sensor to obtain correct output voltage. Tighten retaining screws. Remove voltmeter.

COLD (FAST) IDLE RPM

4.2L

Disconnect and plug EGR valve vacuum hose. With engine running at normal operating temperature, place fast idle screw on second step of fast idle cam and against shoulder of high step. Turn screw to adjust fast idle speed.

FAST IDLE SPEED (RPM) TABLE

Application	Man. Trans.	Auto. Trans.
4.2L	1700	1700

AUTOMATIC CHOKE SETTING

Choke coil cover is riveted in place and no adjustment is necessary or possible.

SERVICING

EMISSION CONTROL

See EMISSIONS section.

SPECIFICATIONS

IGNITION

Distributor

All vehicles use a Motorcraft breakerless solid state distributor.

PICK-UP COIL RESISTANCE TABLE - OHMS @ 75°F (24°C)

Application	Specification
All Models	400-800

TOTAL SPARK ADVANCE TABLE @ 2000 RPM

Application	W/ Vac. Advance	W/O Vac. Advance
4.0L	N/A	N/A
4.2L	30.5°	7.5-12.5°

(1) - Information not available from manufacturer.

IGNITION COIL

IGNITION COIL OUTPUT TABLE @ 1000 RPM

Application	Output
All Models	24KV Minimum

IGNITION COIL RESISTANCE TABLE

Temperature	Primary Ohms	Secondary Ohms
75°F (24°C)	1.13-1.23	7700-9300
200°F (93°C)	1.5	12,000

FUEL SYSTEM

CARBURETORS & FUEL INJECTION TABLE

Application	Model
4.0L	MPFI
4.2L	Carter BBD 2-Bbl.

BATTERY

BATTERY SPECIFICATIONS TABLE

Application **	Cold Cranking (1) Amps	Reserve Capacity Minutes
Standard	421	75
Optional	452	81

(1) - At 0°F (-18°C).

STARTER

All models equipped with Mitsubishi starters.

STARTER SPECIFICATIONS TABLE

Application	Volts	Amps	Test RPM
All Models	11.22	80	2500

ALTERNATOR

All models use Delco-Remy solid state alternators with internal voltage regulator.

ALTERNATOR SPECIFICATIONS TABLE

Application	Field Current	Rated

**	Draw @ 12 Volts	Amp Output
Standard	(1) 4.0-5.0 Amps	56
Optional	(1) 4.0-5.0 Amps	66
Optional	(1) 4.0-5.0 Amps	78

(1) - At 80°F (27°C).

ALTERNATOR REGULATORS

All models use Delco-Remy solid state regulators, integral with alternator. Regulator is nonadjustable.

BELT ADJUSTMENT

BELT ADJUSTMENT TABLE TENSION IN LBS. (KG) USING STRAND TENSION GAUGE

Application	New Belts	Used Belts
"V"-Belts	125-155 (57-70)	90-115 (41-52)
Serpentine	180-200 (82-91)	140-160 (63-72)

REPLACEMENT INTERVALS

REPLACEMENT INTERVALS TABLE

Component	Interval (Miles)
Air Filter	30,000
Fuel Filter	30,000
Oil & Filter	7500
PCV Valve	30,000
Spark Plugs	30,000

CAPACITIES

FLUID CAPACITIES TABLE

Application	Quantity
Auto. Trans. (Dexron II)	
Wrangler	8.0 qts. (7.6L)
All Others	8.5 qts. (8.0L)
Cooling System	
Wrangler	10.5 qts. (9.9L)
All Others	12.0 qts. (11.4L)
Crankcase (Includes Filter)	
Wrangler	5.0 qts. (4.7L)
All Others	6.0 qts. (5.7L)
Drive Axle	
Front	2.5 pts. (1.2L)
Rear	
Comanche	
Standard Capacity	2.5 pts. (1.2L)
Metric Ton Axle	4.8 pts. (2.3L)
All Others	2.5 pts. (1.2L)
Fuel Tank	
Cherokee & Wagoneer	
Standard	13.5 gals. (51L)

Optional	20 gals. (76L)
Comanche	
Standard	16 gals. (60L)
Optional	23.5 gals. (89L)
Wrangler	
Standard	15 gals. (57L)
Optional	20 gals. (75L)
Manual Transmission	
AX4	7.8 pts. (3.7L)
AX5	7.4 pts. (3.5L)
BA 10/5	3.5 pts. (1.6L)
Transfer Case (Dexron II)	
Wrangler	3.25 pts. (1.5L)
All Others	
Command Trac	2.2 pts. (1.0L)
Select Trac	3.0 pts. (1.4L)

SYSTEM REFRIGERANT CAPACITIES TABLE

Application	Ozs.
All Models	36

TURN SIGNALS & HAZARD FLASHERS

1988 Jeep Cherokee

1988 Turn Signal & Hazard Light Systems
JEEP

DESCRIPTION

Turn signals and hazard flashers systems use a common turn signal/hazard light switch assembly mounted within upper steering column housing.

FLASHER LOCATIONS

Hazard
Mounted on fuse block.

Turn Signal
Mounted on fuse block.

TROUBLE SHOOTING

NOTE: Following trouble shooting is only information available from manufacturer.

Hazard Lights (Comanche, Cherokee & Wagoneer)

If lights do not come on with hazard switch turned on, check hazard/stop light fuse by operating stop lights. If fuse is okay, check turn signal flasher, turn signal/hazard switch, and related wiring. If only one hazard light does not work, check bulb.

Turn Signals (Comanche, Cherokee & Wagoneer)

If all turn signals do not work, check turn/back-up light fuse by operating back-up lights. If fuse is okay, check turn signal flasher, turn signal/hazard switch, and related wiring. If only one turn signal does not work, check bulb.

TESTING

NOTE: Following trouble shooting is only information available from manufacturer.

Hazard Indicators (Wrangler)

1) Turn ignition and hazard warning switch "ON". Check for pulsating voltage at Light Blue (left indicator) and Dark Blue (right indicator) wires. If voltage is present, go to next step. If voltage is not present, replace turn signal switch.

2) Remove bulbs for turn signal indicators. Measure resistance across bulb terminals. If resistance is zero ohms, replace light bulb(s). If resistance readings are not zero ohms, go to next step.

3) Check for pulsating voltage at battery side of bulb sockets. If voltage is present, go to next step. If voltage is not present, repair open circuit between socket and turn signal switch steering column connector.

4) Turn ignition off and check resistance on ground side of bulb sockets. If resistance is zero ohms, hazard indicator circuit is okay. If resistance reading is not zero ohms, repair open in ground circuit.

Hazard Lights (Wrangler)

1) Check operation of stop lights. If stop lights come on, go to next step. If not, check hazard/stop light fuse. If fuse is okay, check for voltage on battery side of hazard/stop light fuse. If voltage is not present, repair open circuit between fusible link and fuse block.

2) Remove hazard flasher and check for voltage on battery side of hazard flasher at fuse block. If voltage is present, go to next step. If voltage is not present, repair open circuit to fuse block.

3) Measure resistance across turn signal flasher terminals. If resistance across flasher is zero ohms, replace flasher. If resistance is other than zero ohms, install flasher and turn ignition on.

4) Check for voltage at Brown wire of turn signal switch steering column connector. If voltage is present, go to next step. If voltage is not present, repair open circuit between flasher and turn signal switch connector.

5) Turn hazard warning switch "ON". Check for pulsating voltage at Light Blue, Dark Blue, Yellow, and Dark Green wires. If voltage is present, hazard light circuit is okay. If voltage is not present, replace turn signal switch.

Turn Signals (Wrangler)

1) Turn ignition on and check operation of back-up lights. If lights come on, go to step 3). If back-up lights do not come on, check turn signal/back-up light fuse.

2) If fuse is okay, check for voltage at battery side of turn signal/back-up light fuse. If voltage is not present, repair open circuit between fuse block and ignition switch. If voltage is present, go to next step.

3) Remove turn signal flasher and measure resistance across flasher terminals. If resistance across flasher is zero ohms, replace turn signal flasher. If flasher is okay, install flasher and turn ignition on.

4) Check for voltage on battery side of flasher at fuse block. If voltage is present, go to next step. If voltage is not present, repair open circuit to fuse block.

5) Disconnect turn signal switch at steering column connector. Place turn signal switch in left turn position and measure resistance between Yellow and Purple wires. If resistance across wires is zero ohms, replace turn signal switch. If resistance is other than zero ohms, go to next step.

6) Place turn signal switch in right turn position and measure resistance between Dark Green and Purple wires. If resistance across wires is zero ohms, replace turn signal switch. If resistance is other than zero ohms, turn signal circuit is okay.

Turn Signal Indicators (Wrangler)

1) Turn ignition on. Place turn signal switch in left turn position and check for pulsating voltage at Light Blue wire. If voltage is present, go to next step. If voltage is not present, replace turn signal switch.

2) Place turn signal switch in right turn position and check for pulsating voltage at Dark Blue wire. If voltage is not present, replace turn signal switch. If voltage is present, go to next step.

3) Remove bulbs from turn signal indicators. Measure resistance across bulb terminals. If resistance is zero ohms, replace light bulb(s). If resistance readings are not zero ohms, turn ignition on.

4) Place turn signal switch in left and right turn position and check for pulsating voltage at battery side of bulb sockets. If voltage is present, go to next step. If voltage is not present, repair open circuit between socket(s) and steering column connector.

5) Turn ignition off and check resistance on ground side of bulb sockets. If resistance is zero ohms, turn signal indicator circuit is okay. If resistance reading is not zero ohms, repair open in ground circuit.

UNIVERSAL JOINTS

1988 Jeep Cherokee

1988 Drive Shafts - Universal Joints

All Manufacturers

MAINTENANCE

Whenever drive shaft is removed from vehicle of if slip yoke sticks in extension housing seal, clean yoke with solvent. Lubricate inside diameter of seal with synthetic oil seal lubricant, and outside diameter of seal with transmission fluid.

OVERHAUL

NOTE: Universal joints should not be disassembled unless external leakage or damage has occurred.

Before disassembly, scribe alignment marks on yoke and shaft to allow reassembly in original position. If joints are rusted or corroded, apply penetrating oil before pressing out bearing cups or trunnion pin.

CROSS SHAFT & ROLLER TYPE UNIVERSAL JOINTS

There are 2 different retaining methods used for bearing cups, either snap rings or nylon retainers. Joints with snap rings may be taken apart and reassembled, using same cross shaft and bearings. Joints with nylon retainers are disassembled by breaking nylon retainers. Retainers must be replaced after service.

Removal & Disassembly

1) Disconnect yoke or flange attaching bolts and remove drive shaft from vehicle.

NOTE: DO NOT use a pry bar to hold drive shaft while loosening bolts. Damage to bearing seals may result.

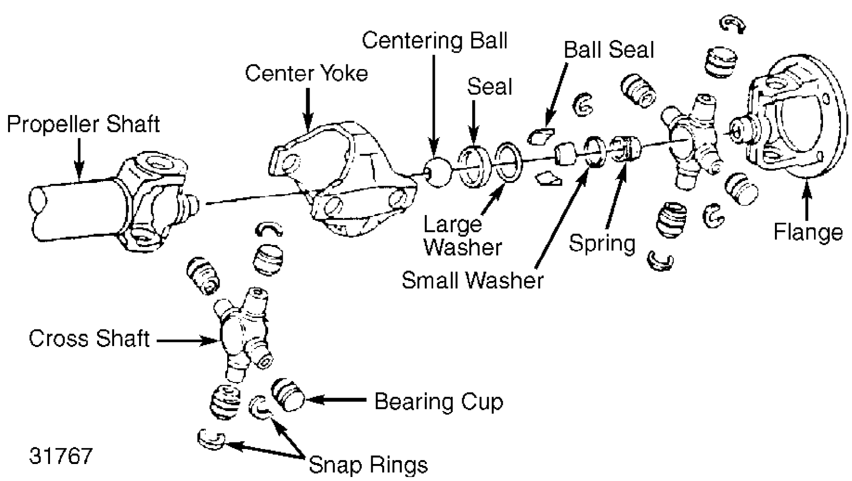

Fig. 1: Exploded View of Jeep Constant Velocity Type Universal Joint

2) Remove retaining strap (if equipped). Remove bushing retainers from yoke. Press out rollers and bearings. Remove last roller and bushing assembly by pressing on end of cross shaft.

3) Remove cross shaft assembly from yoke. DO NOT remove seal retainers from cross shaft. Cross shaft and retainers are serviced as an assembly.

Reassembly

1) Coat roller and bearing assemblies with lubricant, and fill reservoirs in ends of cross. Place cross assembly in drive shaft yoke, and place roller and bushing assemblies into position.

2) Press both bushing assemblies into yoke until retainers can be installed, being careful to keep cross aligned in center of bushings. Install retainers, then repeat procedure for remaining bushings.

CONSTANT VELOCITY (CV) TYPE

NOTE: To prevent damage to constant velocity joints, center ball when removing drive shaft assembly. When handling drive shaft after removal, support shafts on both sides of constant velocity joint if drive shaft is being moved horizontally. DO NOT allow one end to hang free or one shaft to bend at sharp angle. After removal, shaft may be carried vertically without damage.

Removal & Disassembly (Jeep)

1) Disconnect yoke attaching bolts and flange attaching bolts, and remove drive shaft from vehicle. Mark joint so that center yoke, end yoke, and cross shafts will be installed in original positions.

2) Pry out all snap rings and press bearing out enough to allow bearing end to be clamped in vise. Tap on yoke until it is free of bearing.

3) Repeat procedure for remaining bearings. Remove remaining parts from center yoke assembly.

Reassembly

1) Pack all bearings with specified grease. Assemble center yoke components in reverse order of disassembly.

2) Using arbor press or vise, press 2 opposing bearings into osition at same time until all bearings are installed. Be sure cross shafts and yokes remain aligned during this process.

3) Check for free movement of joint. If bind exists, seat bearings by sharply rapping yokes with brass hammer. Never hammer on bearings.

4) Install drive shaft in vehicle, making sure marks made during disassembly are aligned.

Installation (All Models)

NOTE: The drive shaft assembly, with cross and bearings installed, must have its yoke ears at each end of the shaft on same plane.

1) Before installing drive shaft, clean yoke and inspect machined surface for scratches, nicks or burrs.

2) Provide support for drive shaft during installation to prevent damage to universal joints. Position front end of shaft and aligning marks noted during removal.

3) Install and attach 2 clamps to pinion yoke. Install 4 screws and lock washer assemblies on CV joint at transfer case. Use press bar to prevent assembly from rotating while attaching screw assemblies.

VACUUM DIAGRAMS

1988 Jeep Cherokee

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1988 Exhaust Emission Systems
JEEP VACUUM DIAGRAMS
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DIAGRAM ABBREVIATIONS

JEEP VACUUM DIAGRAM ABBREVIATIONS

CTO	Coolant Temperature Override
EGR	Exhaust Gas Recirculation
HDC CTO	Heavy Duty Cooling, Coolant Temperature Override
PCV	Positive Crankcase Ventilation
TAC	Thermostatic Air Cleaner
VSD	Vacuum Signal Dump

VACUUM DIAGRAMS

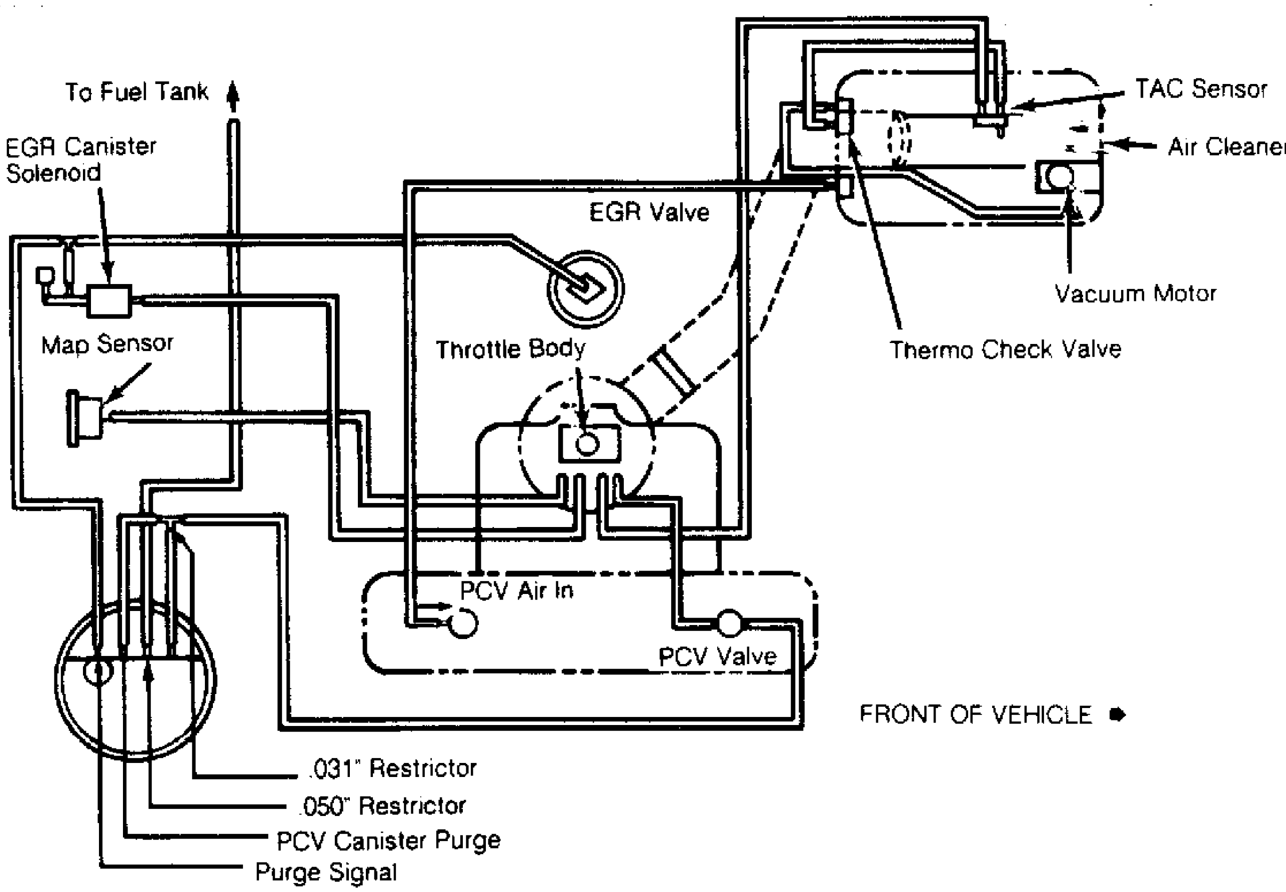


Fig. 1: 2.5L 4-Cylinder
Courtesy of Chrysler Motors.

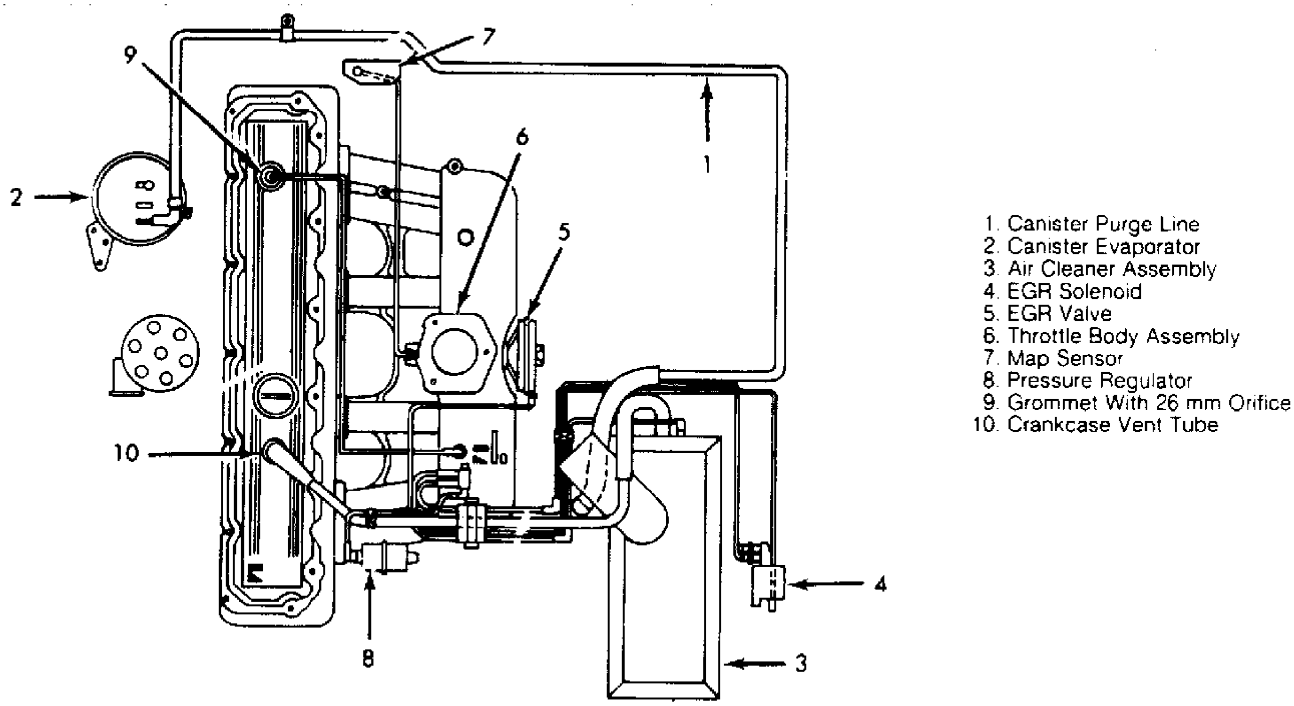


Fig. 2: 4.0L 6-Cylinder
Courtesy of Chrysler Motors.

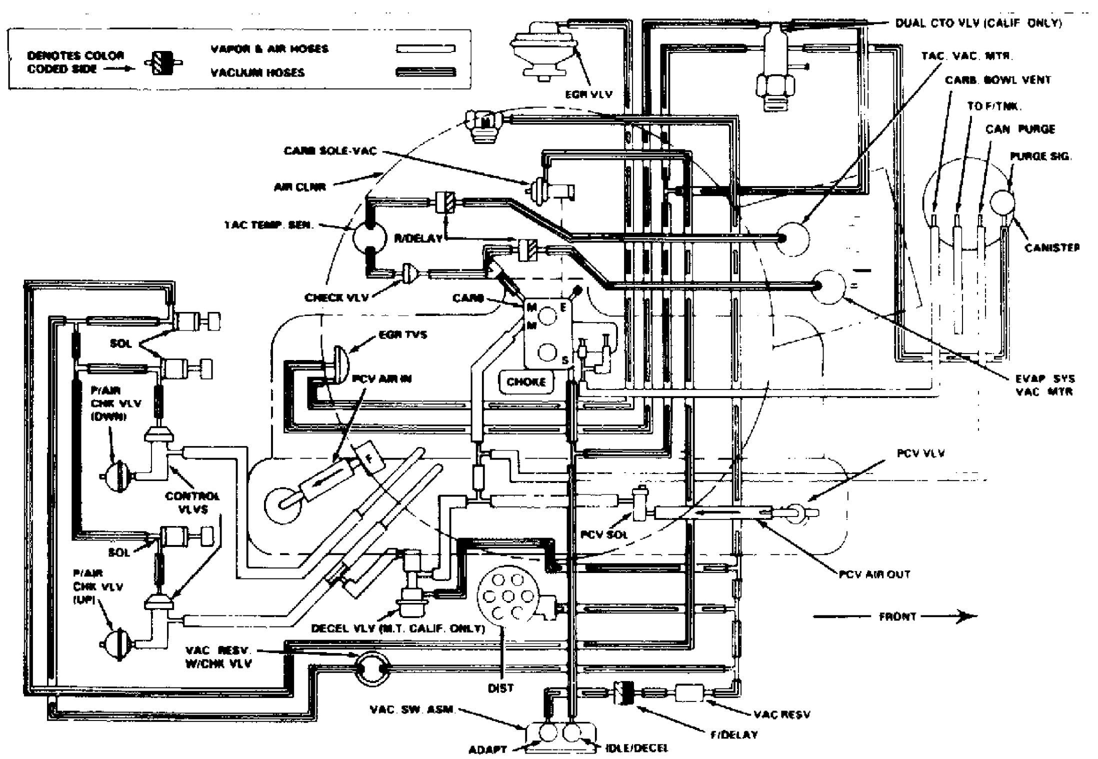


Fig. 3: 4.2L 6-Cylinder
Courtesy of Chrysler Motors.

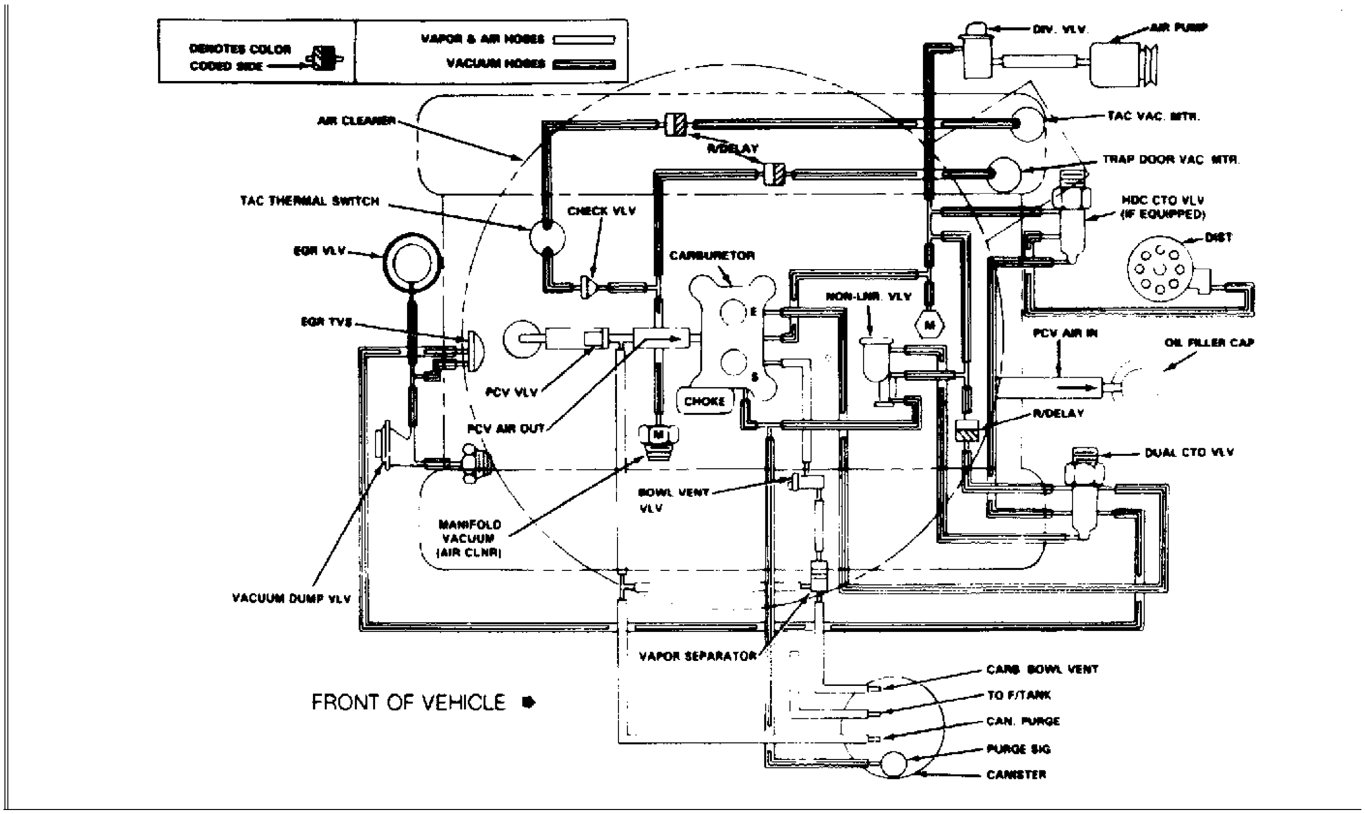


Fig. 4: 6.0L V8
Courtesy of Chrysler Motors.

WAVEFORMS - INJECTOR PATTERN TUTORIAL

1988 Jeep Cherokee

GENERAL INFORMATION
Waveforms - Injector Pattern Tutorial

* PLEASE READ THIS FIRST *

NOTE: This article is intended for general information purposes only. This information may not apply to all makes and models.

PURPOSE OF THIS ARTICLE

Learning how to interpret injector drive patterns from a Lab Scope can be like learning ignition patterns all over again. This article exists to ease you into becoming a skilled injector pattern interpreter.

You will learn:

* How a DVOM and noid light fall short of a lab scope.
* The two types of injector driver circuits, voltage controlled & current controlled.
* The two ways injector circuits can be wired, constant ground/switched power & constant power/switched ground.
* The two different pattern types you can use to diagnose with, voltage & current.
* All the valuable details injector patterns can reveal.

SCOPE OF THIS ARTICLE

This is NOT a manufacturer specific article. All different types of systems are covered here, regardless of the specific year/make/model/engine.

The reason for such broad coverage is because there are only a few basic ways to operate a solenoid-type injector. By understanding the fundamental principles, you will understand all the major points of injector patterns you encounter. Of course there are minor differences in each specific system, but that is where a waveform library helps out.

If this is confusing, consider a secondary ignition pattern. Even though there are many different implementations, each still has a primary voltage turn-on, firing line, spark line, etc.

If specific waveforms are available in On Demand for the engine and vehicle you are working on, you will find them in the Engine Performance section under the Engine Performance category.

IS A LAB SCOPE NECESSARY?

INTRODUCTION

You probably have several tools at your disposal to diagnose injector circuits. But you might have questioned "Is a lab scope necessary to do a thorough job, or will a set of noid lights and a multifunction DVOM do just as well?"

In the following text, we are going to look at what noid lights and DVOMs do best, do not do very well, and when they can mislead you. As you might suspect, the lab scope, with its ability to look inside an active circuit, comes to the rescue by answering for the deficiencies of these other tools.

OVERVIEW OF NOID LIGHT

The noid light is an excellent "quick and dirty" tool. It can usually be hooked to a fuel injector harness fast and the flashing light is easy to understand. It is a dependable way to identify a no-pulse situation.

However, a noid light can be very deceptive in two cases:

* If the wrong one is used for the circuit being tested. Beware: Just because a connector on a noid light fits the harness does not mean it is the right one.
* If an injector driver is weak or a minor voltage drop is present.

Use the Right Noid Light

In the following text we will look at what can happen if the wrong noid light is used, why there are different types of noid lights (besides differences with connectors), how to identify the types of noid lights, and how to know the right type to use.

First, let's discuss what can happen if the incorrect type of noid light is used. You might see:

* A dimly flashing light when it should be normal.
* A normal flashing light when it should be dim.

A noid light will flash dim if used on a lower voltage circuit than it was designed for. A normally operating circuit would appear underpowered, which could be misinterpreted as the cause of a fuel starvation problem.

Here are the two circuit types that could cause this problem:

* Circuits with external injector resistors. Used predominately on some Asian & European systems, they are used to reduce the available voltage to an injector in order to limit the current flow. This lower voltage can cause a dim flash on a noid light designed for full voltage.
* Circuits with current controlled injector drivers (e.g. "Peak and Hold"). Basically, this type of driver allows a quick burst of voltage/current to flow and then throttles it back significantly for the remainder of the pulse width duration. If a noid light was designed for the other type of driver (voltage controlled, e.g. "Saturated"), it will appear dim because it is expecting full voltage/current to flow for the entire duration of the pulse width.

Let's move to the other situation where a noid light flashes normally when it should be dim. This could occur if a more sensitive noid light is used on a higher voltage/amperage circuit that was weakened enough to cause problems (but not outright broken). A circuit with an actual problem would thus appear normal.

Let's look at why. A noid light does not come close to consuming as much amperage as an injector solenoid. If there is a partial driver failure or a minor voltage drop in the injector circuit, there can be adequate amperage to fully operate the noid light BUT NOT ENOUGH TO OPERATE THE INJECTOR.

If this is not clear, picture a battery with a lot of corrosion on the terminals. Say there is enough corrosion that the starter motor will not operate; it only clicks. Now imagine turning on the headlights (with the ignition in the RUN position). You find they light normally and are fully bright. This is the same idea as noid light: There is a problem, but enough amp flow exists to operate the headlights ("noid light"), but not the starter motor ("injector").

How do you identify and avoid all these situations? By using the correct type of noid light. This requires that you understanding

the types of injector circuits that your noid lights are designed for. There are three. They are:

* Systems with a voltage controlled injector driver. Another way to say it: The noid light is designed for a circuit with a "high" resistance injector (generally 12 ohms or above).
* Systems with a current controlled injector driver. Another way to say it: The noid light is designed for a circuit with a low resistance injector (generally less than 12 ohms) without an external injector resistor.
* Systems with a voltage controlled injector driver and an external injector resistor. Another way of saying it: The noid light is designed for a circuit with a low resistance injector (generally less than 12 ohms) and an external injector resistor.

NOTE: Some noid lights can meet both the second and third categories simultaneously.

If you are not sure which type of circuit your noid light is designed for, plug it into a known good car and check out the results. If it flashes normally during cranking, determine the circuit type by finding out injector resistance and if an external injector resistor is used. You now know enough to identify the type of injector circuit. Label the noid light appropriately.

Next time you need to use a noid light for diagnosis, determine what type of injector circuit you are dealing with and select the appropriate noid light.

Of course, if you suspect a no-pulse condition you could plug in any one whose connector fit without fear of misdiagnosis. This is because it is unimportant if the flashing light is dim or bright. It is only important that it flashes.

In any cases of doubt regarding the use of a noid light, a lab scope will overcome all inherent weaknesses.

OVERVIEW OF DVOM

A DVOM is typically used to check injector resistance and available voltage at the injector. Some techs also use it check injector on-time either with a built-in feature or by using the dwell/duty function.

There are situations where the DVOM performs these checks dependably, and other situations where it can deceive you. It is important to be aware of these strengths and weaknesses. We will cover the topics above in the following text.

Checking Injector Resistance

If a short in an injector coil winding is constant, an ohmmeter will accurately identify the lower resistance. The same is true with an open winding. Unfortunately, an intermittent short is an exception. A faulty injector with an intermittent short will show "good" if the ohmmeter cannot force the short to occur during testing.

Alcohol in fuel typically causes an intermittent short, happening only when the injector coil is hot and loaded by a current high enough to jump the air gap between two bare windings or to break down any oxides that may have formed between them.

When you measure resistance with an ohmmeter, you are only applying a small current of a few milliamps. This is nowhere near enough to load the coil sufficiently to detect most problems. As a result, most resistance checks identify intermittently shorted injectors as being normal.

There are two methods to get around this limitation. The first is to purchase an tool that checks injector coil windings under

full load. The Kent-Moore J-39021 is such a tool, though there are others. The Kent-Moore costs around $240 at the time of this writing and works on many different manufacturer's systems.

The second method is to use a lab scope. Remember, a lab scope allows you to see the regular operation of a circuit in real time. If an injector is having an short or intermittent short, the lab scope will show it.

Checking Available Voltage At the Injector

Verifying a fuel injector has the proper voltage to operate correctly is good diagnostic technique. Finding an open circuit on the feed circuit like a broken wire or connector is an accurate check with a DVOM. Unfortunately, finding an intermittent or excessive resistance problem with a DVOM is unreliable.

Let's explore this drawback. Remember that a voltage drop due to excessive resistance will only occur when a circuit is operating? Since the injector circuit is only operating for a few milliseconds at a time, a DVOM will only see a potential fault for a few milliseconds. The remaining 90+% of the time the unloaded injector circuit will show normal battery voltage.

Since DVOMs update their display roughly two to five times a second, all measurements in between are averaged. Because a potential voltage drop is visible for such a small amount of time, it gets "averaged out", causing you to miss it.

Only a DVOM that has a "min-max" function that checks EVERY MILLISECOND will catch this fault consistently (if used in that mode). The Fluke 87 among others has this capability.

A "min-max" DVOM with a lower frequency of checking (100 millisecond) can miss the fault because it will probably check when the injector is not on. This is especially true with current controlled driver circuits. The Fluke 88, among others fall into this category.

Outside of using a Fluke 87 (or equivalent) in the 1 mS "min-max" mode, the only way to catch a voltage drop fault is with a lab scope. You will be able to see a voltage drop as it happens.

One final note. It is important to be aware that an injector circuit with a solenoid resistor will always show a voltage drop when the circuit is energized. This is somewhat obvious and normal; it is a designed-in voltage drop. What can be unexpected is what we already covered--a voltage drop disappears when the circuit is unloaded. The unloaded injector circuit will show normal battery voltage at the injector. Remember this and do not get confused.

Checking Injector On-Time With Built-In Function

Several DVOMs have a feature that allows them to measure injector on-time (mS pulse width). While they are accurate and fast to hookup, they have three limitations you should be aware of:

* They only work on voltage controlled injector drivers (e.g "Saturated Switch"), NOT on current controlled injector drivers (e.g. "Peak & Hold").
* A few unusual conditions can cause inaccurate readings.
* Varying engine speeds can result in inaccurate readings.

Regarding the first limitation, DVOMs need a well-defined injector pulse in order to determine when the injector turns ON and OFF. Voltage controlled drivers provide this because of their simple switch-like operation. They completely close the circuit for the entire duration of the pulse. This is easy for the DVOM to interpret.

The other type of driver, the current controlled type, start off well by completely closing the circuit (until the injector pintle opens), but then they throttle back the voltage/current for the duration of the pulse. The DVOM understands the beginning of the pulse

but it cannot figure out the throttling action. In other words, it cannot distinguish the throttling from an open circuit (de-energized) condition.

Yet current controlled injectors will still yield a millisecond on-time reading on these DVOMs. You will find it is also always the same, regardless of the operating conditions. This is because it is only measuring the initial completely-closed circuit on-time, which always takes the same amount of time (to lift the injector pintle off its seat). So even though you get a reading, it is useless.

The second limitation is that a few erratic conditions can cause inaccurate readings. This is because of a DVOM's slow display rate; roughly two to five times a second. As we covered earlier, measurements in between display updates get averaged. So conditions like skipped injector pulses or intermittent long/short injector pulses tend to get "averaged out", which will cause you to miss important details.

The last limitation is that varying engine speeds can result in inaccurate readings. This is caused by the quickly shifting injector on-time as the engine load varies, or the RPM moves from a state of acceleration to stabilization, or similar situations. It too is caused by the averaging of all measurements in between DVOM display periods. You can avoid this by checking on-time when there are no RPM or load changes.

A lab scope allows you to overcome each one of these limitations.

Checking Injector On-Time With Dwell Or Duty

If no tool is available to directly measure injector millisecond on-time measurement, some techs use a simple DVOM dwell or duty cycle functions as a replacement.

While this is an approach of last resort, it does provide benefits. We will discuss the strengths and weaknesses in a moment, but first we will look at how a duty cycle meter and dwell meter work.

How A Duty Cycle Meter and Dwell Meter Work

All readings are obtained by comparing how long something has been OFF to how long it has been ON in a fixed time period. A dwell meter and duty cycle meter actually come up with the same answers using different scales. You can convert freely between them. See RELATIONSHIP BETWEEN DWELL & DUTY CYCLE READINGS TABLE.

The DVOM display updates roughly one time a second, although some DVOMs can be a little faster or slower. All measurements during this update period are tallied inside the DVOM as ON time or OFF time, and then the total ratio is displayed as either a percentage (duty cycle) or degrees (dwell meter).

For example, let's say a DVOM had an update rate of exactly 1 second (1000 milliseconds). Let's also say that it has been measuring/tallying an injector circuit that had been ON a total of 250 mS out of the 1000 mS. That is a ratio of one-quarter, which would be displayed as 25% duty cycle or 15° dwell (six-cylinder scale). Note that most duty cycle meters can reverse the readings by selecting the positive or negative slope to trigger on. If this reading were reversed, a duty cycle meter would display 75%.

Strengths of Dwell/Duty Meter

The obvious strength of a dwell/duty meter is that you can compare injector on-time against a known-good reading. This is the only practical way to use a dwell/duty meter, but requires you to have known-good values to compare against.

Another strength is that you can roughly convert injector mS on-time into dwell reading with some computations.

A final strength is that because the meter averages everything together it does not miss anything (though this is also a

severe weakness that we will look at later). If an injector has a fault where it occasionally skips a pulse, the meter registers it and the reading changes accordingly.

Let's go back to figuring out dwell/duty readings by using injector on-time specification. This is not generally practical, but we will cover it for completeness. You NEED to know three things:

* Injector mS on-time specification.
* Engine RPM when specification is valid.
* How many times the injectors fire per crankshaft revolution.

The first two are self-explanatory. The last one may require some research into whether it is a bank-fire type that injects every 360° of crankshaft rotation, a bank-fire that injects every 720°, or an SFI that injects every 720°. Many manufacturers do not release this data so you may have to figure it out yourself with a frequency meter.

Here are the four complete steps to convert millisecond on-time:

1) Determine the injector pulse width and RPM it was obtained at. Let's say the specification is for one millisecond of on-time at a hot idle of 600 RPM.

2) Determine injector firing method for the complete 4 stroke cycle. Let's say this is a 360° bank-fired, meaning an injector fires each and every crankshaft revolution.

3) Determine how many times the injector will fire at the specified engine speed (600 RPM) in a fixed time period. We will use 100 milliseconds because it is easy to use.

Six hundred crankshaft Revolutions Per Minute (RPM) divided by 60 seconds equals 10 revolutions per second.

Multiplying 10 times .100 yields one; the crankshaft turns one time in 100 milliseconds. With exactly one crankshaft rotation in 100 milliseconds, we know that the injector fires exactly one time.

4) Determine the ratio of injector on-time vs. off-time in the fixed time period, then figure duty cycle and/or dwell. The injector fires one time for a total of one millisecond in any given 100 millisecond period.

One hundred minus one equals 99. We have a 99% duty cycle. If we wanted to know the dwell (on 6 cylinder scale), multiple 99% times .6; this equals 59.4° dwell.

Weaknesses of Dwell/Duty Meter

The weaknesses are significant. First, there is no one-to-one correspondence to actual mS on-time. No manufacturer releases dwell/duty data, and it is time-consuming to convert the mS on-time readings. Besides, there can be a large degree of error because the conversion forces you to assume that the injector(s) are always firing at the same rate for the same period of time. This can be a dangerous assumption.

Second, all level of detail is lost in the averaging process. This is the primary weakness. You cannot see the details you need to make a confident diagnosis.

Here is one example. Imagine a vehicle that has a faulty injector driver that occasionally skips an injector pulse. Every skipped pulse means that that cylinder does not fire, thus unburned O2 gets pushed into the exhaust and passes the O2 sensor. The O2 sensor indicates lean, so the computer fattens up the mixture to compensate for the supposed "lean" condition.

A connected dwell/duty meter would see the fattened pulse width but would also see the skipped pulses. It would tally both and likely come back with a reading that indicated the "pulse width" was within specification because the rich mixture and missing pulses offset each other.

This situation is not a far-fetched scenario. Some early GM

3800 engines were suffering from exactly this. The point is that a lack of detail could cause misdiagnosis.

As you might have guessed, a lab scope would not miss this.

RELATIONSHIP BETWEEN DWELL & DUTY CYCLE READINGS TABLE (1)

Dwell Meter (2)	Duty Cycle Meter
1°	1%
15°	25%
30°	50%
45°	75%
60°	100%

(1) - These are just some examples for your understanding. It is okay to fill in the gaps.
(2) - Dwell meter on the six-cylinder scale.

THE TWO TYPES OF INJECTOR DRIVERS

OVERVIEW

There are two types of transistor driver circuits used to operate electric fuel injectors: voltage controlled and current controlled. The voltage controlled type is sometimes called a "saturated switch" driver, while the current controlled type is sometimes known as a "peak and hold" driver.

The basic difference between the two is the total resistance of the injector circuit. Roughly speaking, if a particular leg in an injector circuit has total resistance of 12 or more ohms, a voltage control driver is used. If less than 12 ohms, a current control driver is used.

It is a question of what is going to do the job of limiting the current flow in the injector circuit; the inherent "high" resistance in the injector circuit, or the transistor driver. Without some form of control, the current flow through the injector would cause the solenoid coil to overheat and result in a damaged injector.

VOLTAGE CONTROLLED CIRCUIT ("SATURATED SWITCH")

The voltage controlled driver inside the computer operates much like a simple switch because it does not need to worry about limiting current flow. Recall, this driver typically requires injector circuits with a total leg resistance of 12 or more ohms.

The driver is either ON, closing/completing the circuit (eliminating the voltage-drop), or OFF, opening the circuit (causing a total voltage drop).

Some manufacturers call it a "saturated switch" driver. This is because when switched ON, the driver allows the magnetic field in the injector to build to saturation. This is the same "saturation" property that you are familiar with for an ignition coil.

There are two ways "high" resistance can be built into an injector circuit to limit current flow. One method uses an external solenoid resistor and a low resistance injector, while the other uses a high resistance injector without the solenoid resistor. See the left side of Fig. 1.

In terms of injection opening time, the external resistor voltage controlled circuit is somewhat faster than the voltage controlled high resistance injector circuit. The trend, however, seems to be moving toward use of this latter type of circuit due to its lower cost and reliability. The ECU can compensate for slower opening

times by increasing injector pulse width accordingly.

NOTE: Never apply battery voltage directly across a low resistance injector. This will cause injector damage from solenoid coil overheating.

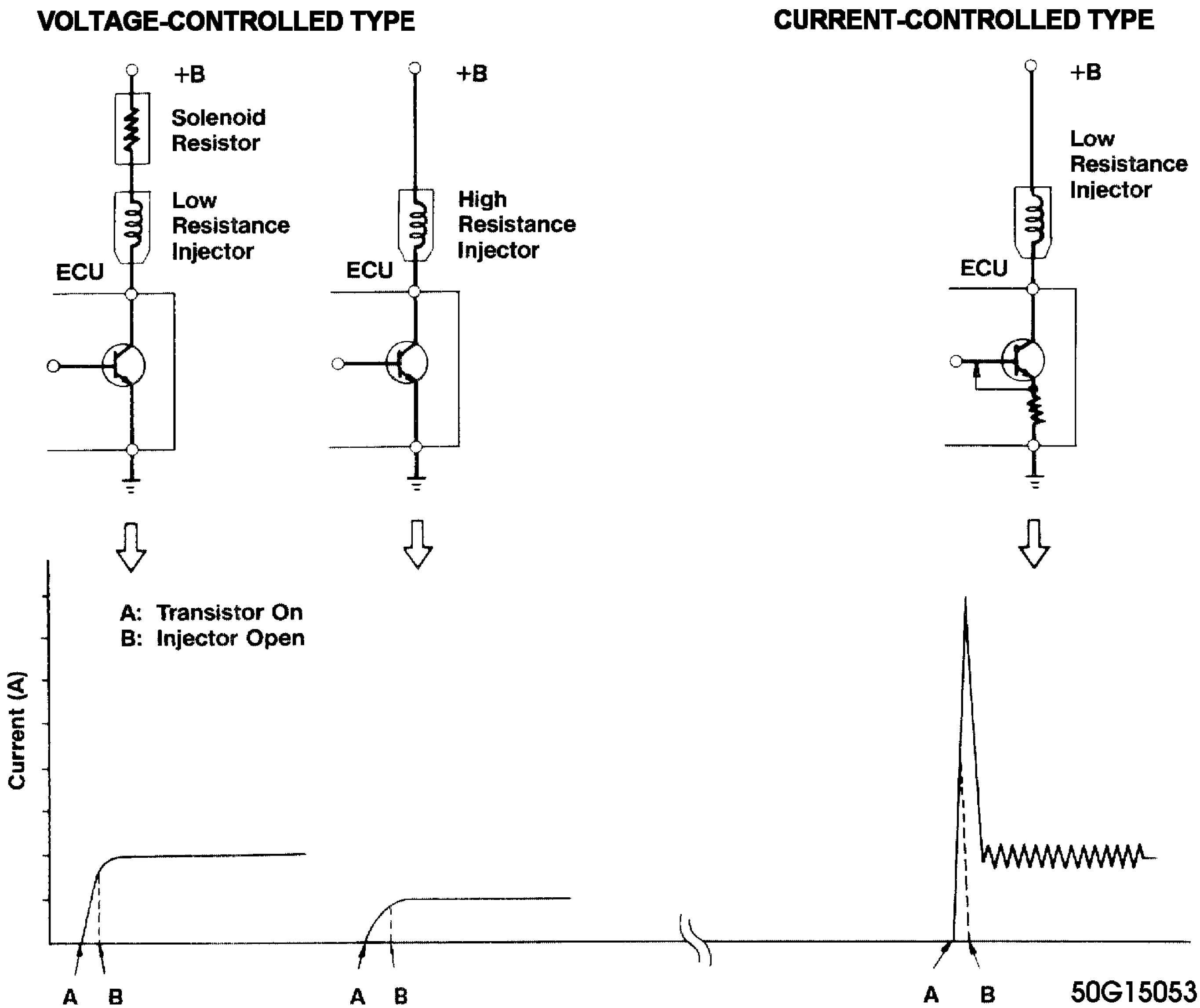


Fig. 1: Injector Driver Types - Current and Voltage

CURRENT CONTROLLED CIRCUIT ("PEAK & HOLD")

The current controlled driver inside the computer is more complex than a voltage controlled driver because as the name implies, it has to limit current flow in addition to its ON-OFF switching function. Recall, this driver typically requires injector circuits with a total leg resistance of less than 12 ohms.

Once the driver is turned ON, it will not limit current flow until enough time has passed for the injector pintle to open. This period is preset by the particular manufacturer/system based on the amount of current flow needed to open their injector. This is typically between two and six amps. Some manufacturers refer to this

as the "peak" time, referring to the fact that current flow is allowed to "peak" (to open the injector).

Once the injector pintle is open, the amp flow is considerably reduced for the rest of the pulse duration to protect the injector from overheating. This is okay because very little amperage is needed to hold the injector open, typically in the area of one amp or less. Some manufacturers refer to this as the "hold" time, meaning that just enough current is allowed through the circuit to "hold" the already-open injector open.

There are a couple methods of reducing the current. The most common trims back the available voltage for the circuit, similar to turning down a light at home with a dimmer.

The other method involves repeatedly cycling the circuit ON-OFF. It does this so fast that the magnetic field never collapses and the pintle stays open, but the current is still significantly reduced. See the right side of Fig. 1 for an illustration.

The advantage to the current controlled driver circuit is the short time period from when the driver transistor goes ON to when the injector actually opens. This is a function of the speed with which current flow reaches its peak due to the low circuit resistance. Also, the injector closes faster when the driver turns OFF because of the lower holding current.

NOTE: Never apply battery voltage directly across a low resistance injector. This will cause injector damage from solenoid coil overheating.

THE TWO WAYS INJECTOR CIRCUITS ARE WIRED

Like other circuits, injector circuits can be wired in one of two fundamental directions. The first method is to steadily power the injectors and have the computer driver switch the ground side of the circuit. Conversely, the injectors can be steadily grounded while the driver switches the power side of the circuit.

There is no performance benefit to either method. Voltage controlled and current controlled drivers have been successfully implemented both ways.

However, 95% percent of the systems are wired so the driver controls the ground side of the circuit. Only a handful of systems use the drivers on the power side of the circuit. Some examples of the latter are the 1970's Cadillac EFI system, early Jeep 4.0 EFI (Renix system), and Chrysler 1984-87 TBI.

INTERPRETING INJECTOR WAVEFORMS

INTERPRETING A VOLTAGE CONTROLLED PATTERN

NOTE: Voltage controlled drivers are also known as "Saturated Switch" drivers. They typically require injector circuits with a total leg resistance of 12 ohms or more.

NOTE: This example is based on a constant power/switched ground circuit.

* See Fig. 2 for pattern that the following text describes.

Point "A" is where system voltage is supplied to the injector. A good hot run voltage is usually 13.5 or more volts. This point, commonly known as open circuit voltage, is critical because the injector will not get sufficient current saturation if there is a voltage shortfall. To obtain a good look at this precise point, you

will need to shift your Lab Scope to five volts per division.

You will find that some systems have slight voltage fluctuations here. This can occur if the injector feed wire is also used to power up other cycling components, like the ignition coil(s). Slight voltage fluctuations are normal and are no reason for concern. Major voltage fluctuations are a different story, however. Major voltage shifts on the injector feed line will create injector performance problems. Look for excessive resistance problems in the feed circuit if you see big shifts and repair as necessary.

Note that circuits with external injector resistors will not be any different because the resistor does not affect open circuit voltage.

Point "B" is where the driver completes the circuit to ground. This point of the waveform should be a clean square point straight down with no rounded edges. It is during this period that current saturation of the injector windings is taking place and the driver is heavily stressed. Weak drivers will distort this vertical line.

Point "C" represents the voltage drop across the injector windings. Point "C" should come very close to the ground reference point, but not quite touch. This is because the driver has a small amount of inherent resistance. Any significant offset from ground is an indication of a resistance problem on the ground circuit that needs repaired. You might miss this fault if you do not use the negative battery post for your Lab Scope hook-up, so it is HIGHLY recommended that you use the battery as your hook-up.

The points between "B" and "D" represent the time in milliseconds that the injector is being energized or held open. This line at Point "C" should remain flat. Any distortion or upward bend indicates a ground problem, short problem, or a weak driver. Alert readers will catch that this is exactly opposite of the current controlled type drivers (explained in the next section), because they bend upwards at this point.

How come the difference? Because of the total circuit resistance. Voltage controlled driver circuits have a high resistance of 12+ ohms that slows the building of the magnetic field in the injector. Hence, no counter voltage is built up and the line remains flat.

On the other hand, the current controlled driver circuit has low resistance which allows for a rapid magnetic field build-up. This causes a slight inductive rise (created by the effects of counter voltage) and hence, the upward bend. You should not see that here with voltage controlled circuits.

Point "D" represents the electrical condition of the injector windings. The height of this voltage spike (inductive kick) is proportional to the number of windings and the current flow through them. The more current flow and greater number of windings, the more potential for a greater inductive kick. The opposite is also true. The less current flow or fewer windings means less inductive kick. Typically you should see a minimum 35 volts at the top of Point "D".

If you do see approximately 35 volts, it is because a zener diode is used with the driver to clamp the voltage. Make sure the beginning top of the spike is squared off, indicating the zener dumped the remainder of the spike. If it is not squared, that indicates the spike is not strong enough to make the zener fully dump, meaning the injector has a weak winding.

If a zener diode is not used in the computer, the spike from a good injector will be 60 or more volts.

Point "E" brings us to a very interesting section. As you can see, the voltage dissipates back to supply value after the peak of the inductive kick. Notice the slight hump? This is actually the mechanical injector pintle closing. Recall that moving an iron core through a magnetic field will create a voltage surge. The pintle is

the iron core here.

This pintle hump at Point "E" should occur near the end of the downward slope, and not afterwards. If it does occur after the slope has ended and the voltage has stabilized, it is because the pintle is slightly sticking because of a faulty injector

If you see more than one hump it is because of a distorted pintle or seat. This faulty condition is known as "pintle float".

It is important to realize that it takes a good digital storage oscilloscope or analog lab scope to see this pintle hump clearly. Unfortunately, it cannot always be seen.

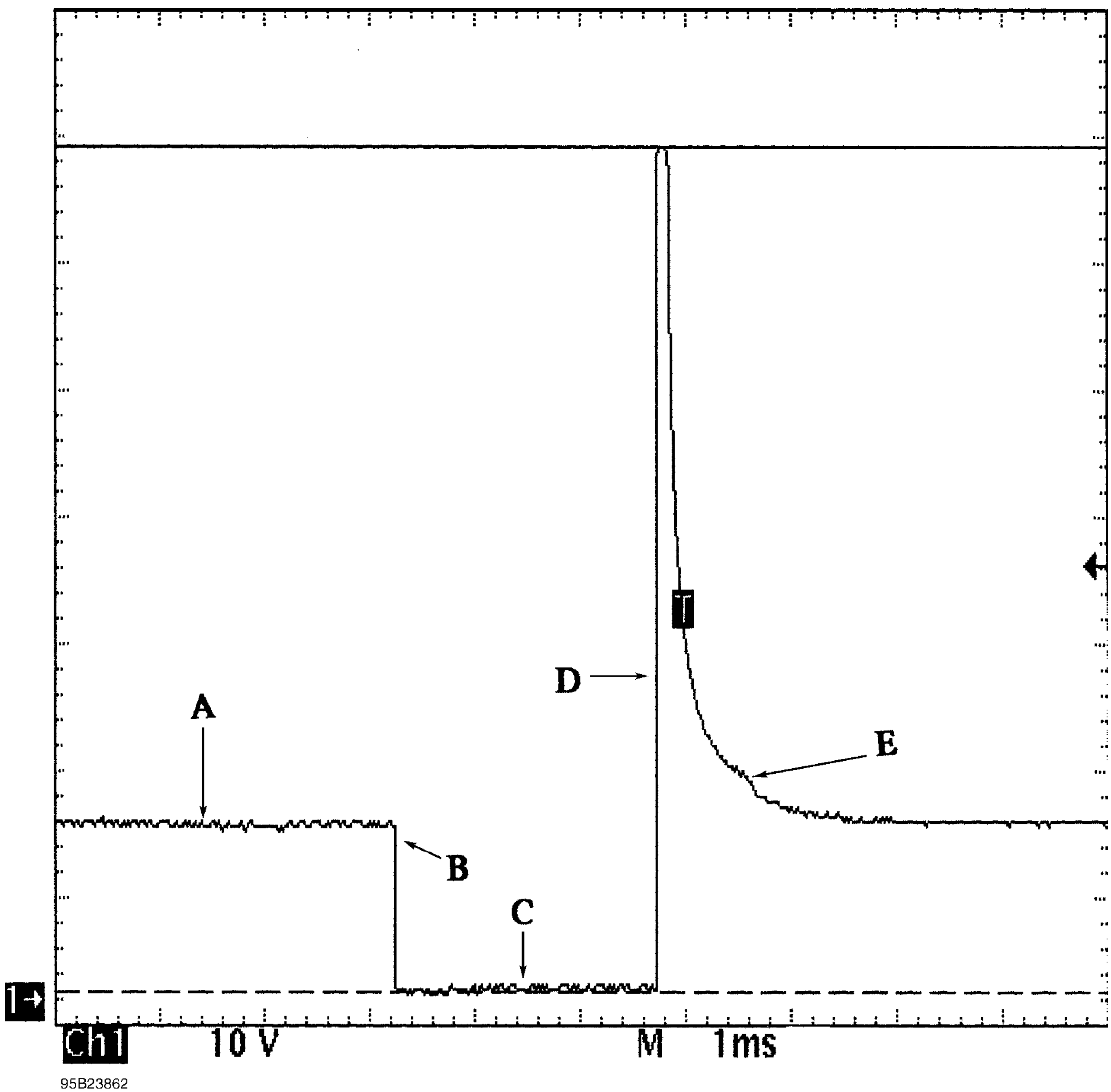


Fig. 2: Identifying Voltage Controlled Type Injector Pattern

INTERPRETING A CURRENT CONTROLLED PATTERN

NOTE: Current controlled drivers are also known as "Peak and Hold"

drivers. They typically require injector circuits with a total leg resistance with less than 12 ohm.

NOTE: This example is based on a constant power/switched ground circuit.

* See Fig. 3 for pattern that the following text describes.

Point "A" is where system voltage is supplied to the injector. A good hot run voltage is usually 13.5 or more volts. This point, commonly known as open circuit voltage, is critical because the injector will not get sufficient current saturation if there is a voltage shortfall. To obtain a good look at this precise point, you will need to shift your Lab Scope to five volts per division.

You will find that some systems have slight voltage fluctuations here. This could occur if the injector feed wire is also used to power up other cycling components, like the ignition coil(s). Slight voltage fluctuations are normal and are no reason for concern. Major voltage fluctuations are a different story, however. Major voltage shifts on the injector feed line will create injector performance problems. Look for excessive resistance problems in the feed circuit if you see big shifts and repair as necessary.

Point "B" is where the driver completes the circuit to ground. This point of the waveform should be a clean square point straight down with no rounded edges. It is during this period that current saturation of the injector windings is taking place and the driver is heavily stressed. Weak drivers will distort this vertical line.

Point "C" represents the voltage drop across the injector windings. Point "C" should come very close to the ground reference point, but not quite touch. This is because the driver has a small amount of inherent resistance. Any significant offset from ground is an indication of a resistance problem on the ground circuit that needs repaired. You might miss this fault if you do not use the negative battery post for your Lab Scope hook-up, so it is HIGHLY recommended that you use the battery as your hook-up.

Right after Point "C", something interesting happens. Notice the trace starts a normal upward bend. This slight inductive rise is created by the effects of counter voltage and is normal. This is because the low circuit resistance allowed a fast build-up of the magnetic field, which in turn created the counter voltage.

Point "D" is the start of the current limiting, also known as the "Hold" time. Before this point, the driver had allowed the current to free-flow ("Peak") just to get the injector pintle open. By the time point "D" occurs, the injector pintle has already opened and the computer has just significantly throttled the current back. It does this by only allowing a few volts through to maintain the minimum current required to keep the pintle open.

The height of the voltage spike seen at the top of Point "D" represents the electrical condition of the injector windings. The height of this voltage spike (inductive kick) is proportional to the number of windings and the current flow through them. The more current flow and greater number of windings, the more potential for a greater inductive kick. The opposite is also true. The less current flow or fewer windings means less inductive kick. Typically you should see a minimum 35 volts.

If you see approximately 35 volts, it is because a zener diode is used with the driver to clamp the voltage. Make sure the beginning top of the spike is squared off, indicating the zener dumped the remainder of the spike. If it is not squared, that indicates the spike is not strong enough to make the zener fully dump, meaning there is a problem with a weak injector winding.

If a zener diode is not used in the computer, the spike from

a good injector will be 60 or more volts.

At Point "E", notice that the trace is now just a few volts below system voltage and the injector is in the current limiting, or the "Hold" part of the pattern. This line will either remain flat and stable as shown here, or will cycle up and down rapidly. Both are normal methods to limit current flow. Any distortion may indicate shorted windings.

Point "F" is the actual turn-off point of the driver (and injector). To measure the millisecond on-time of the injector, measure between points "C" and "F". Note that we used cursors to do it for us; they are measuring a 2.56 mS on-time.

The top of Point "F" (second inductive kick) is created by the collapsing magnetic field caused by the final turn-off of the driver. This spike should be like the spike on top of point "D".

Point "G" shows a slight hump. This is actually the mechanical injector pintle closing. Recall that moving an iron core through a magnetic field will create a voltage surge. The pintle is the iron core here.

This pintle hump at Point "E" should occur near the end of the downward slope, and not afterwards. If it does occur after the slope has ended and the voltage has stabilized, it is because the pintle is slightly sticking. Some older Nissan TBI systems suffered from this.

If you see more than one hump it is because of a distorted pintle or seat. This faulty condition is known as "pintle float".

It is important to realize that it takes a good digital storage oscilloscope or analog lab scope to see this pintle hump clearly. Unfortunately, it cannot always be seen.

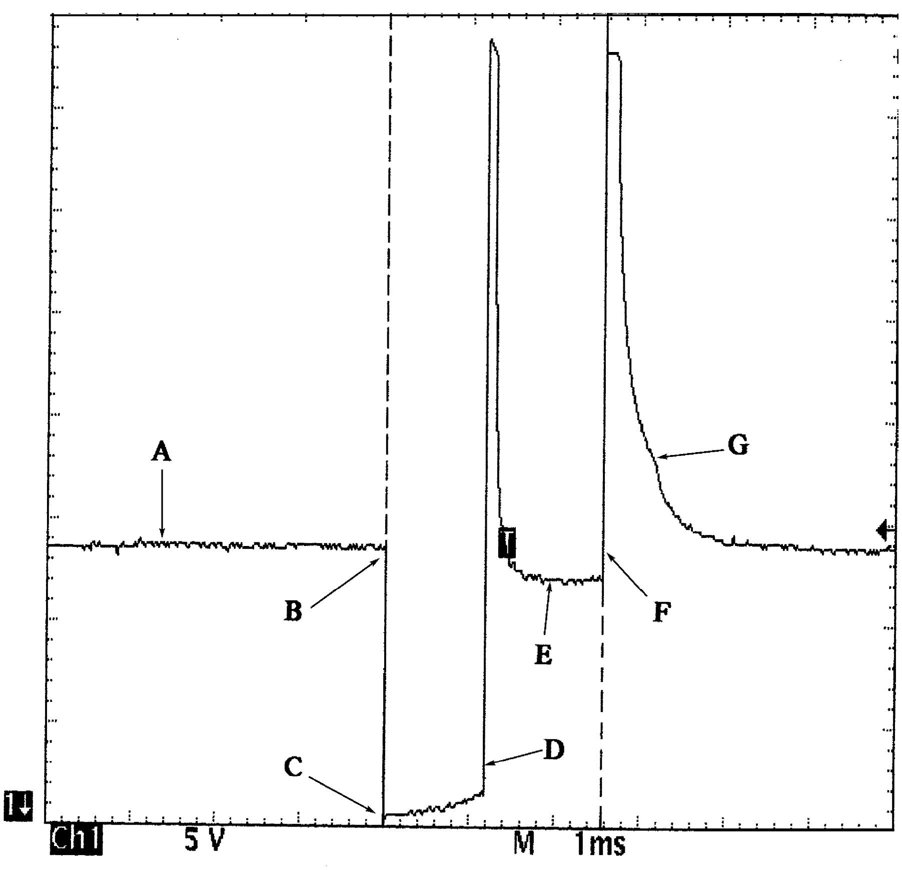


Fig. 3: Identifying Current Controlled Type Injector Pattern

CURRENT WAVEFORM SAMPLES

EXAMPLE #1 - VOLTAGE CONTROLLED DRIVER

The waveform pattern shown in Fig. 4 indicate a normal current waveform from a Ford 3.0L V6 VIN [U] engine. This voltage controlled type circuit pulses the injectors in groups of three injectors. Injectors No. 1, 3, and 5 are pulsed together and cylinders 2, 4, and 6 are pulsed together. The specification for an acceptable bank resistance is 4.4 ohms. Using Ohm’s Law and assuming a hot run voltage of 14 volts, we determine that the bank would draw a current of 3.2 amps.

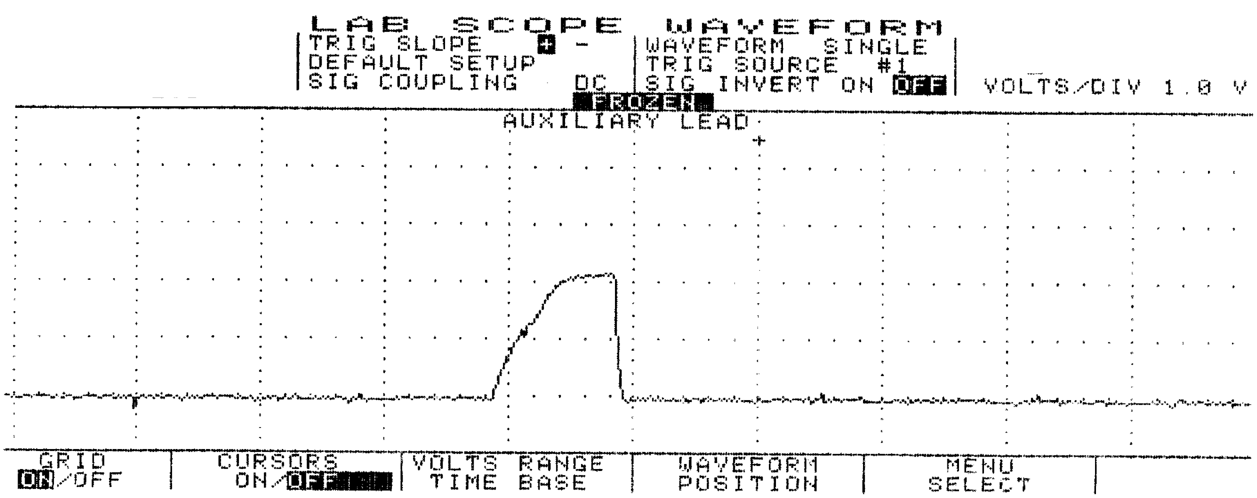
However this is not the case because as the injector windings become saturated, counter voltage is created which impedes the current flow. This, coupled with the inherent resistance of the driver’s transistor, impedes the current flow even more. So, what is a known good value for a dynamic current draw on a voltage controlled bank of injectors? The waveform pattern shown below indicates a good parallel injector current flow of 2 amps. See Fig. 4.

Note that if just one injector has a resistance problem and partially shorts, the entire parallel bank that it belongs to will draw more current. This can damage the injector driver.

The waveform pattern in Fig. 5 indicates this type of problem with too much current flow. This is on other bank of injectors of the same vehicle; the even side. Notice the Lab Scope is set on a one amp per division scale. As you can see, the current is at an unacceptable 2.5 amps.

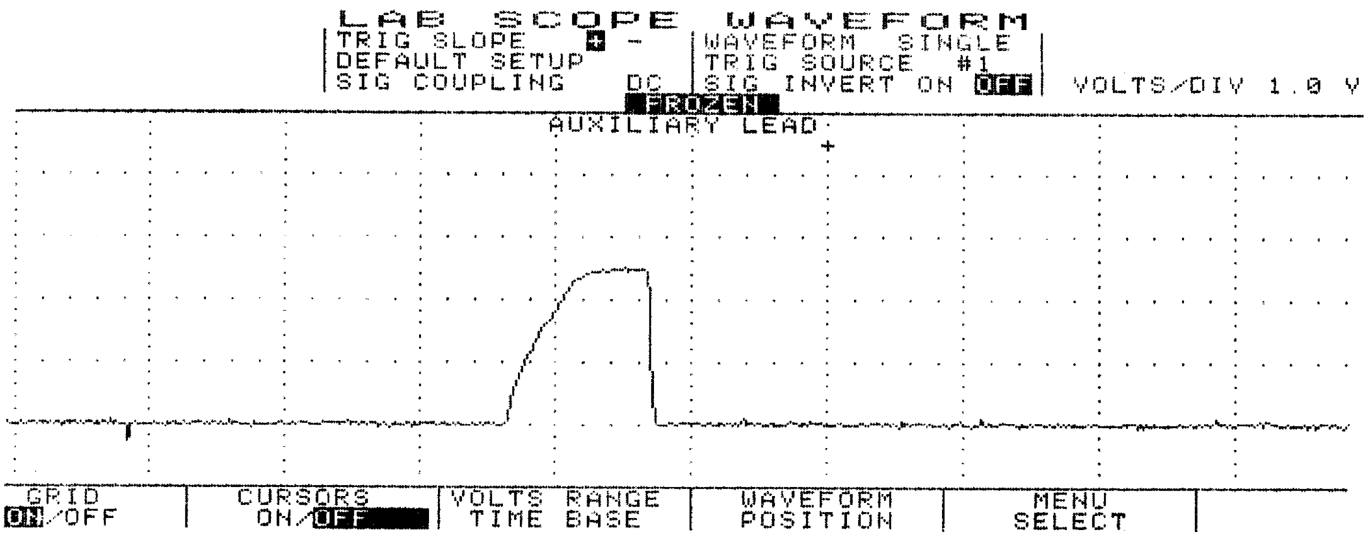
It is easy to find out which individual injector is at fault. All you need to do is inductively clamp onto each individual injector and compare them. To obtain a known-good value to compare against, we used the good bank to capture the waveform in Fig. 6. Notice that it limits current flow to 750 milliamps.

The waveform shown in Fig. 7 illustrates the problem injector we found. This waveform indicates an unacceptable current draw of just over one amp as compared to the 750 milliamp draw of the known-good injector. A subsequent check with a DVOM found 8.2 ohms, which is under the 12 ohm specification.



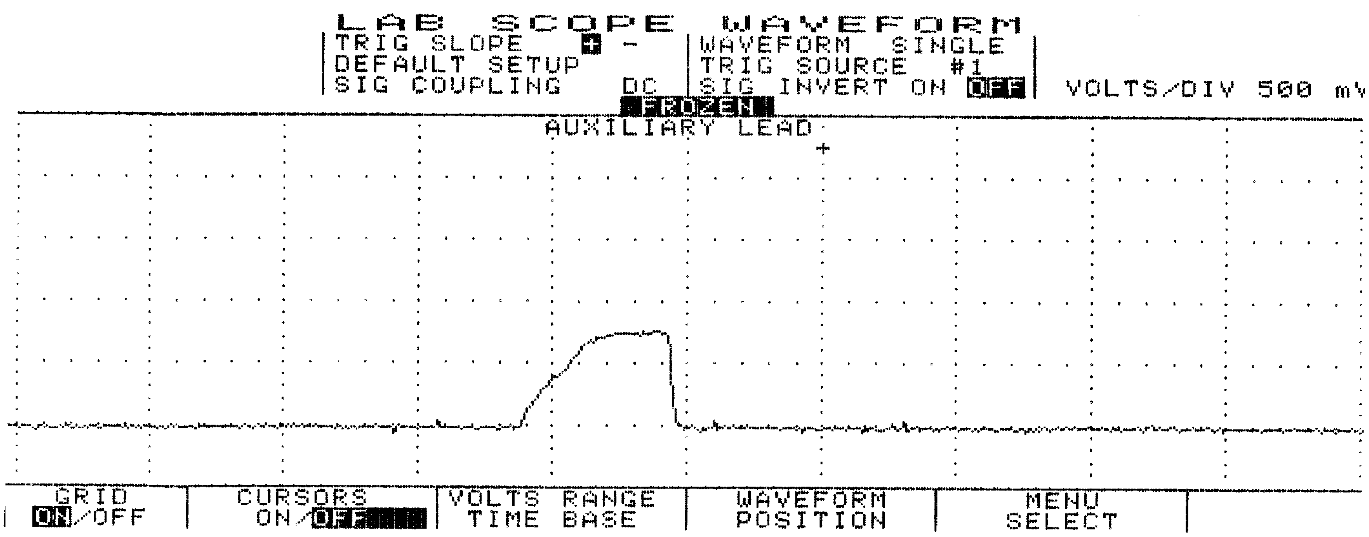
95D23864

Fig. 4: Injector Bank w/Normal Current Flow - Current Pattern



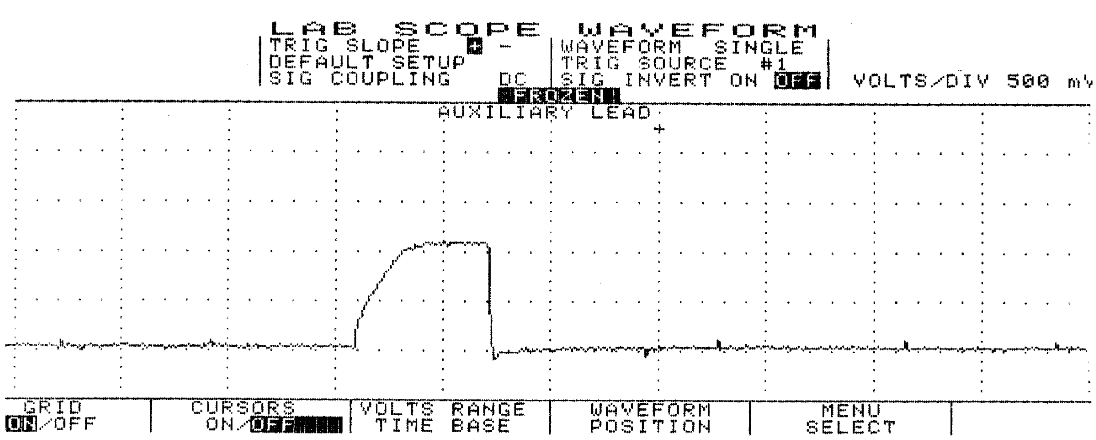
95E23865

Fig. 5: Injector Bank w/Excessive Current Flow - Current Pattern



95F23866

Fig. 6: Single Injector w/Normal Current Flow - Current Pattern



95G23867

Fig. 7: Single Injector w/Excessive Current Flow - Current Pattern

EXAMPLE #2 - VOLTAGE CONTROLLED DRIVER

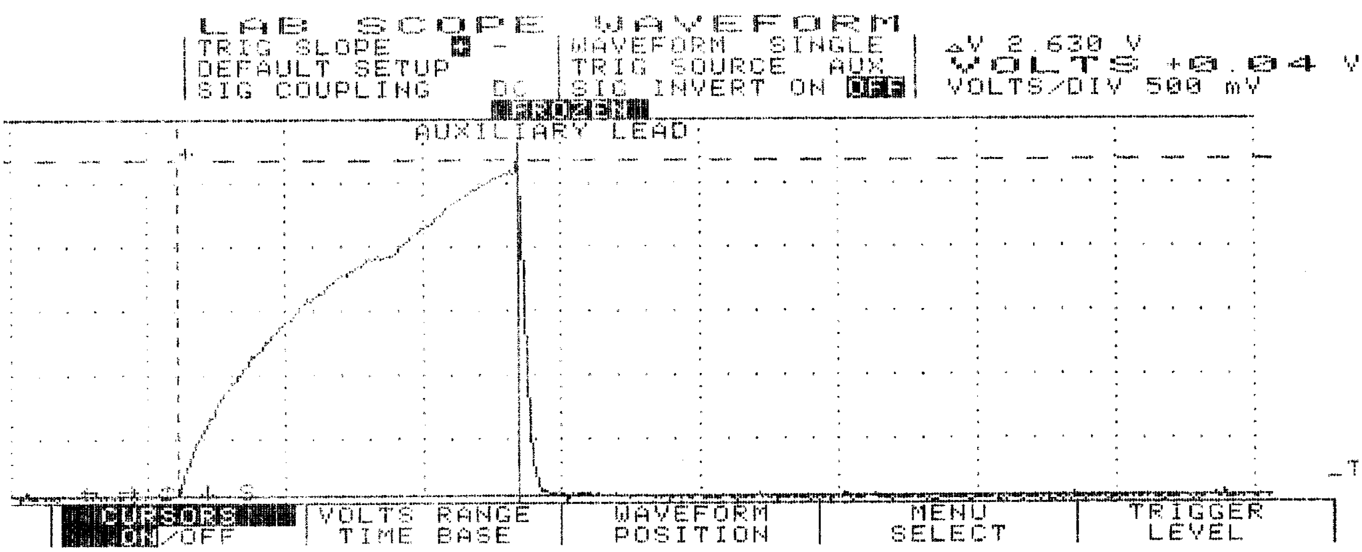
This time we will look at a GM 3.1L V6 VIN [T]. Fig. 8 shows the 1, 3, 5 (odd) injector bank with the current waveform indicating about a 2.6 amp draw at idle. This pattern, taken from a known good vehicle, correctly stays at or below the maximum 2.6 amps current range. Ideally, the current for each bank should be very close in comparison.

Notice the small dimple on the current flow's rising edge. This is the actual injector opening or what engineers refer to as the "set point." For good idle quality, the set point should be uniform between the banks.

When discussing Ohm's Law as it pertains to this parallel circuit, consider that each injector has specified resistance of 12.2 ohms. Since all three injectors are in parallel the total resistance of this parallel circuit drops to 4.1 ohms. Fourteen volts divided by four ohms would pull a maximum of 3.4 amps on this bank of injectors. However, as we discussed in EXAMPLE #1 above, other factors knock this value down to roughly the 2.6 amp neighborhood.

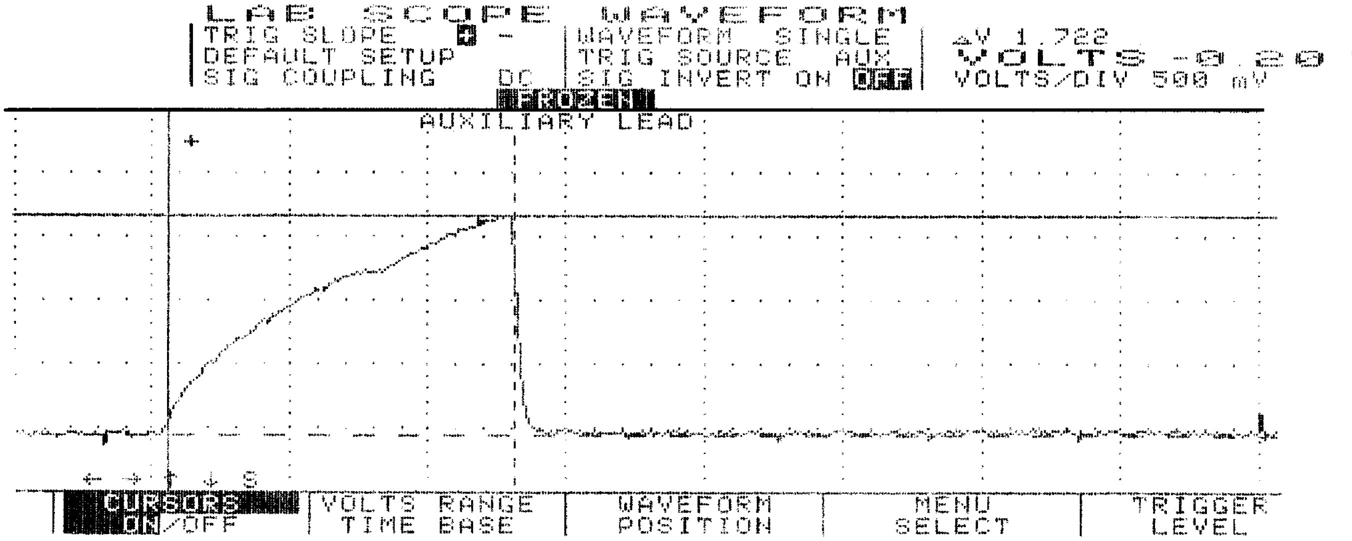
Now we are going to take a look at the even bank of injectors; injectors 2, 4, and 6. See Fig. 9. Notice this bank peaked at 1.7 amps at idle as compared to the 2.6 amps peak of the odd bank (Fig. 8). Current flow between even and odd injectors banks is not uniform, yet it is not causing a driveability problem. That is because it is still under the maximum amperage we figured out earlier. But be aware this vehicle could develop a problem if the amperage flow increases any more.

Checking the resistance of this even injector group with a DVOM yielded 6.2 ohms, while the odd injector group in the previous example read 4.1 ohms.



95E23873

Fig. 8: Injector Odd Bank w/Normal Current Flow - Current Pattern



95F23874

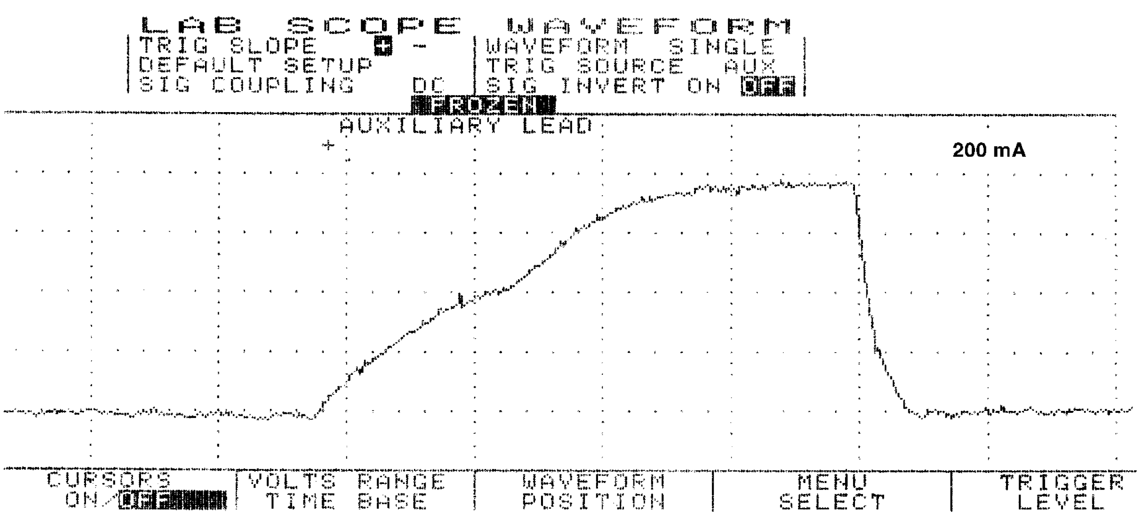
Fig. 9: Injector Even Bank w/Normal Current Flow - Current Pattern

EXAMPLE #3 - VOLTAGE CONTROLLED DRIVER

Example #3 is of a Ford 5.0L V8 SEFI. Fig. 10 shows a waveform of an individual injector at idle with the Lab Scope set on 200 milliamps per division. Notice the dimple in the rising edge. This dimple indicates the actual opening of the injector (set point) occurred at 400 milliamps and current peaked at 750 milliamps. This is a good specification for this engine.

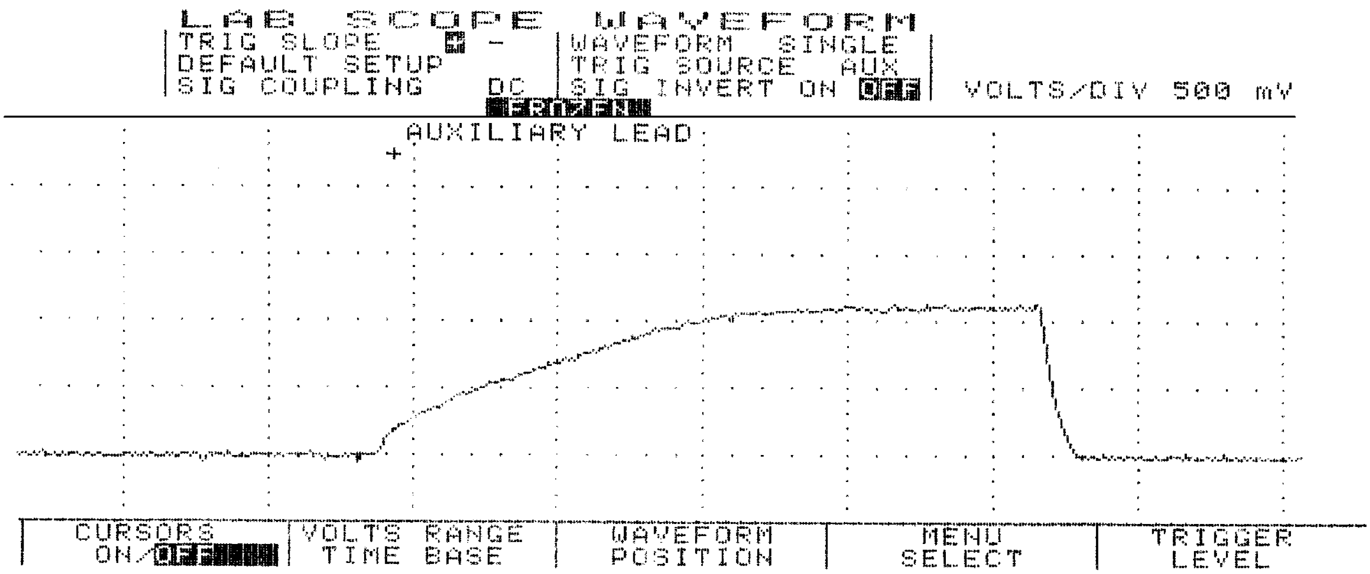
The next waveform pattern in Fig. 11 shows an abnormality with another injector. With the Lab Scope set on 500 milliamps per division, you can see that the current waveform indicates a 1200 milliamp draw. This is a faulty injector.

Abnormally low resistance injectors create excessive current draw, causing rough idle, and possible computer driver damage.



95G23875

Fig. 10: Single Injector w/Normal Current Flow - Current Pattern

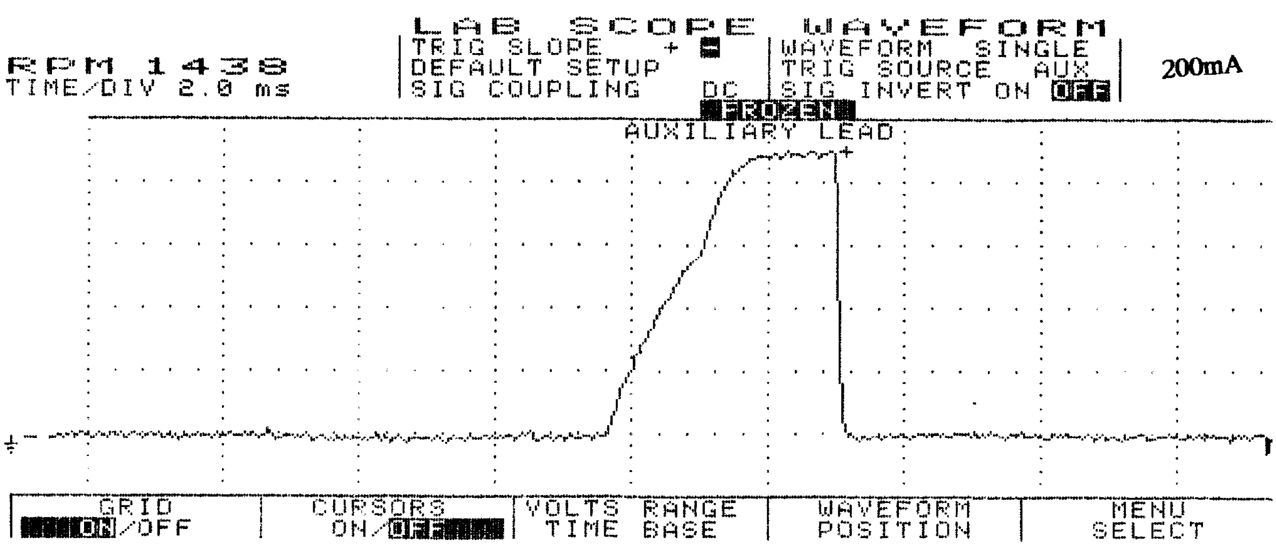


95H23876
Fig. 11: Single Injector w/Excessive Current Flow - Current Pattern

EXAMPLE #4 - CURRENT CONTROLLED DRIVER

Example #4 is of a Ford 4.6L SEFI VIN [W]. See Fig. 12 for the known-good waveform pattern. This Ford system is different from the one above in EXAMPLE #3 as it peaks at 900 milliamps and the actual opening of the injector (set point) is just below 600 milliamps.

This is offered as a comparison against the Ford pattern listed above, as they are both Ford SEFI injectors but with different operating ranges. The point is that you should not make any broad assumptions for any manufacturer.

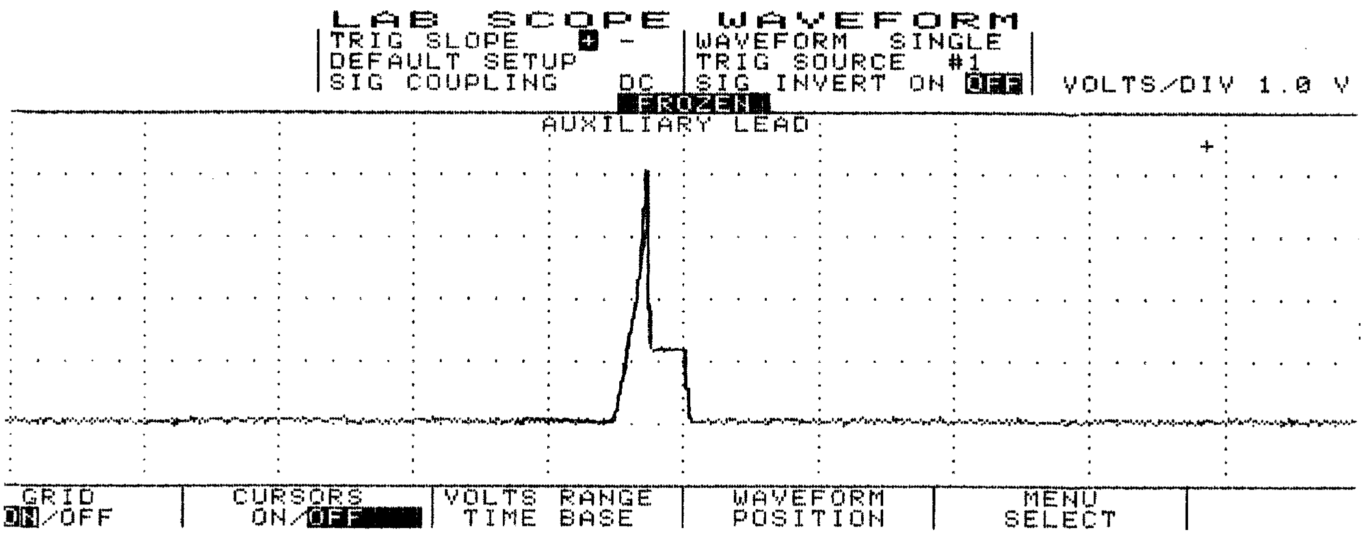


95D23872
Fig. 12: Single Injector w/Normal Current Flow - Current Pattern

EXAMPLE #5 - CURRENT CONTROLLED DRIVER

The known-good waveform in Fig. 13 is from a Chrysler 3.0L V6

PFI VIN [3]. It is a perfect example of the peak and hold theory. The waveform shows a 1-amp per division current flow, ramping to 4 amps and then decreasing to 1-amp to hold the injector open.

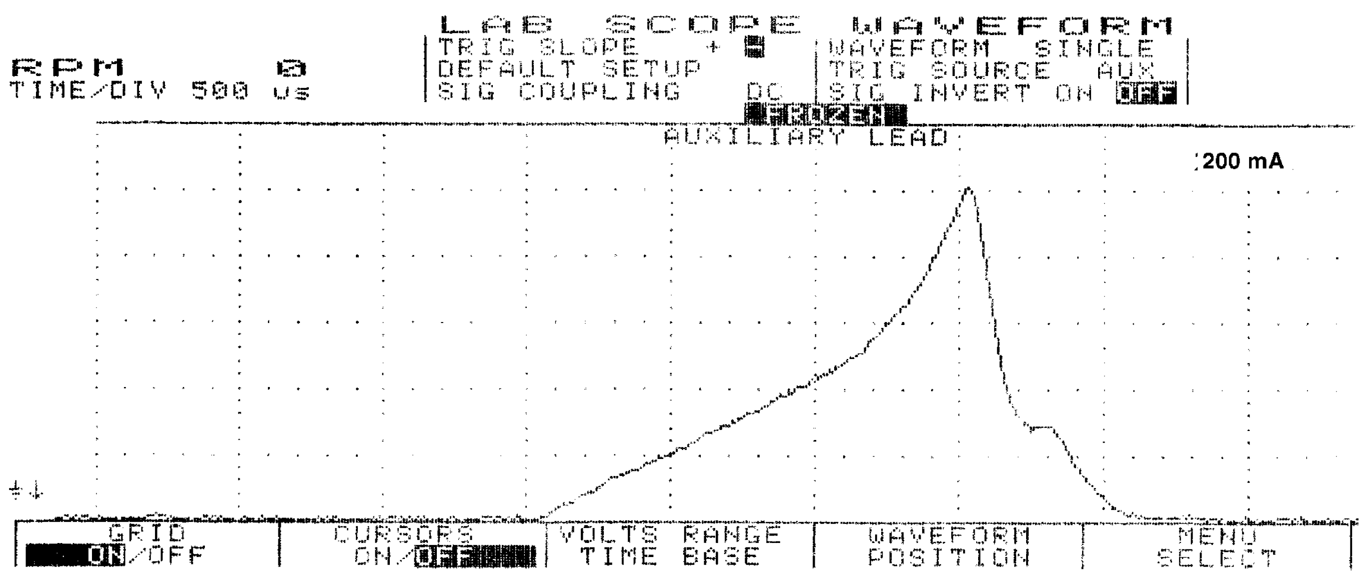


95H23868

Fig. 13: Injector Bank w/Normal Current Flow - Current Pattern

EXAMPLE #6 - CURRENT CONTROLLED DRIVER

This next known-good waveform is from a Ford 5.0L V8 CFI VIN [F]. See Fig. 14. The pattern, which is set on a 250 milliamps scale, indicates a 1.25 amp peak draw and a hold at 350 milliamps.



95I23869

Fig. 14: Single Injector w/Normal Current Flow - Current Pattern

EXAMPLE #7 - CURRENT CONTROLLED DRIVER

The known-good current controlled type waveform in Fig. 15 is from a GM 2.0L TBI VIN [1]. With the lab scope set at 2 amps per division, notice that this system peaks at 4 amps and holds at 1 amp.

The next waveform is from the same type of engine, except

that it shows a faulty injector. See Fig. 16. Notice that the current went to almost 5 amps and stayed at 1 amp during the hold pattern. Excessive amounts of current flow from bad injectors are a common source of intermittent computer shutdown. Using a current waveform pattern is the most accurate method of pinpointing this problem.

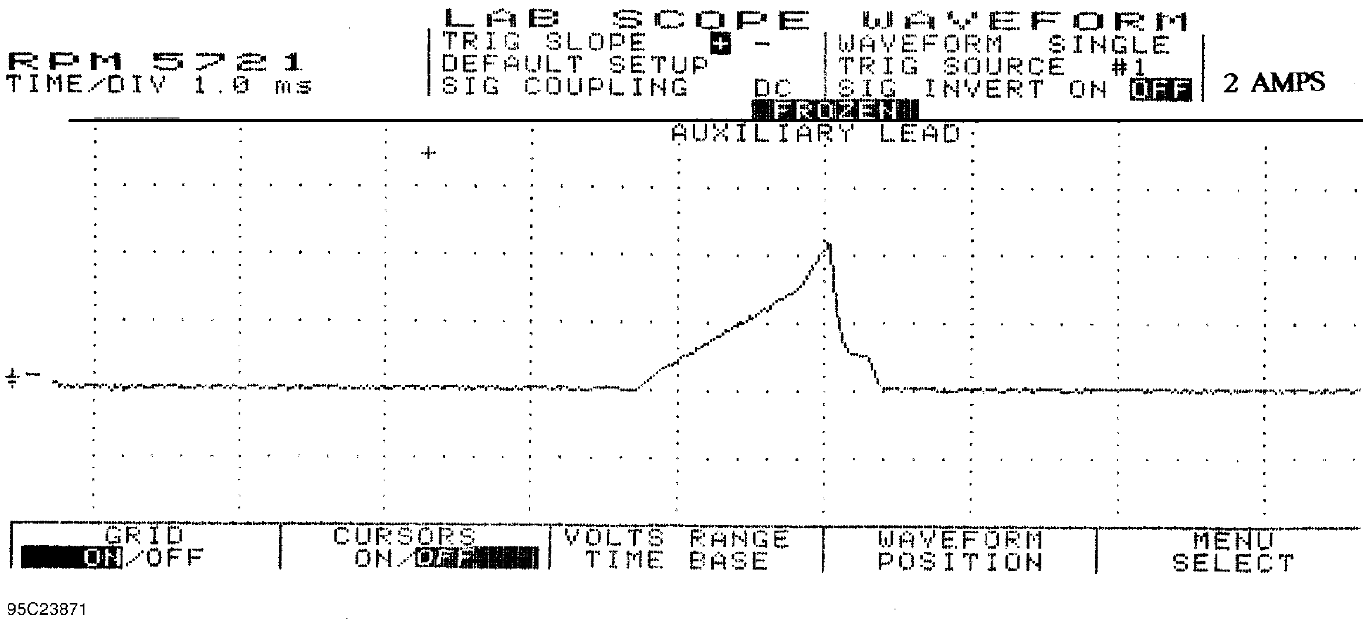


Fig. 15: Single Injector w/Normal Current Flow - Current Pattern

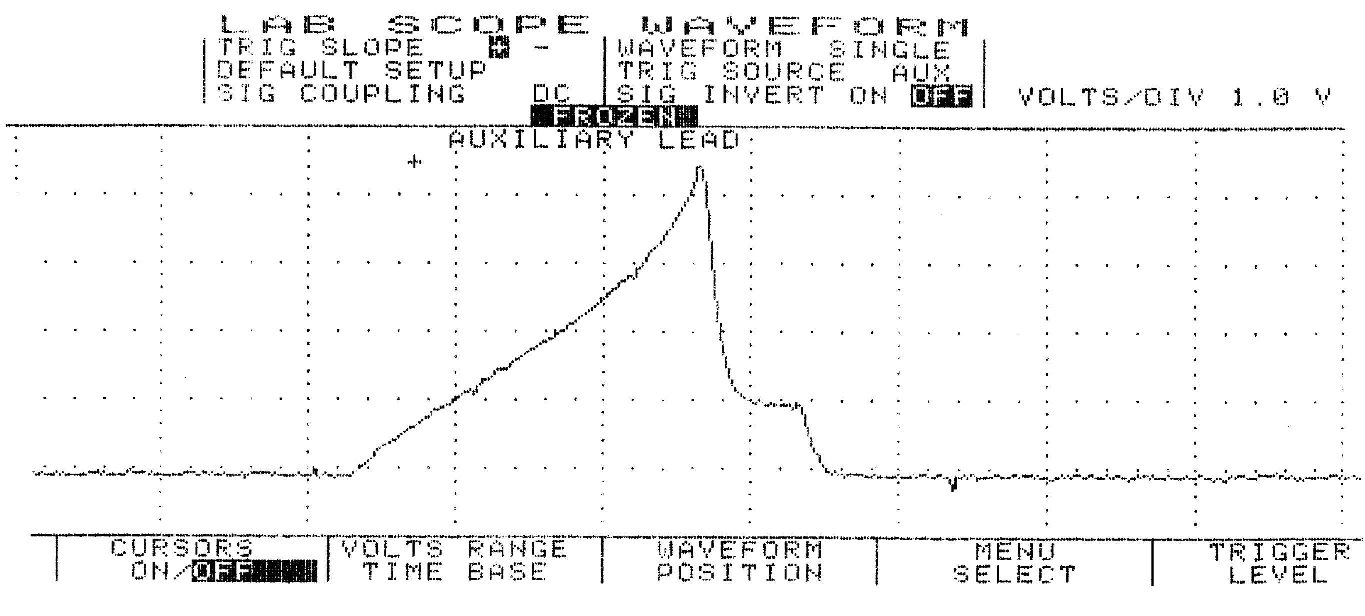


Fig. 16: Single Injector w/Excessive Current Flow - Current Pattern

EXAMPLE #8 - CURRENT CONTROLLED DRIVER

This known-good CPI system waveform from a GM 4.3L V6 CPI VIN [W] peaks at 4 amps and holds at 1-amp. See Fig. 17 for waveform.

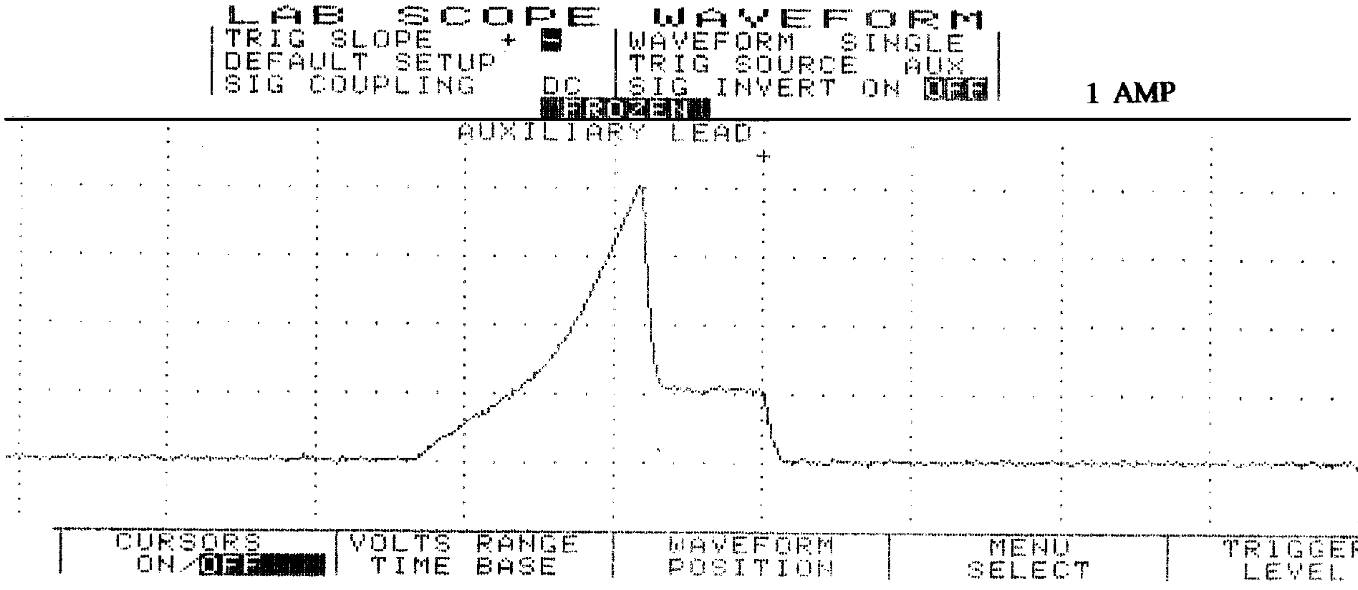
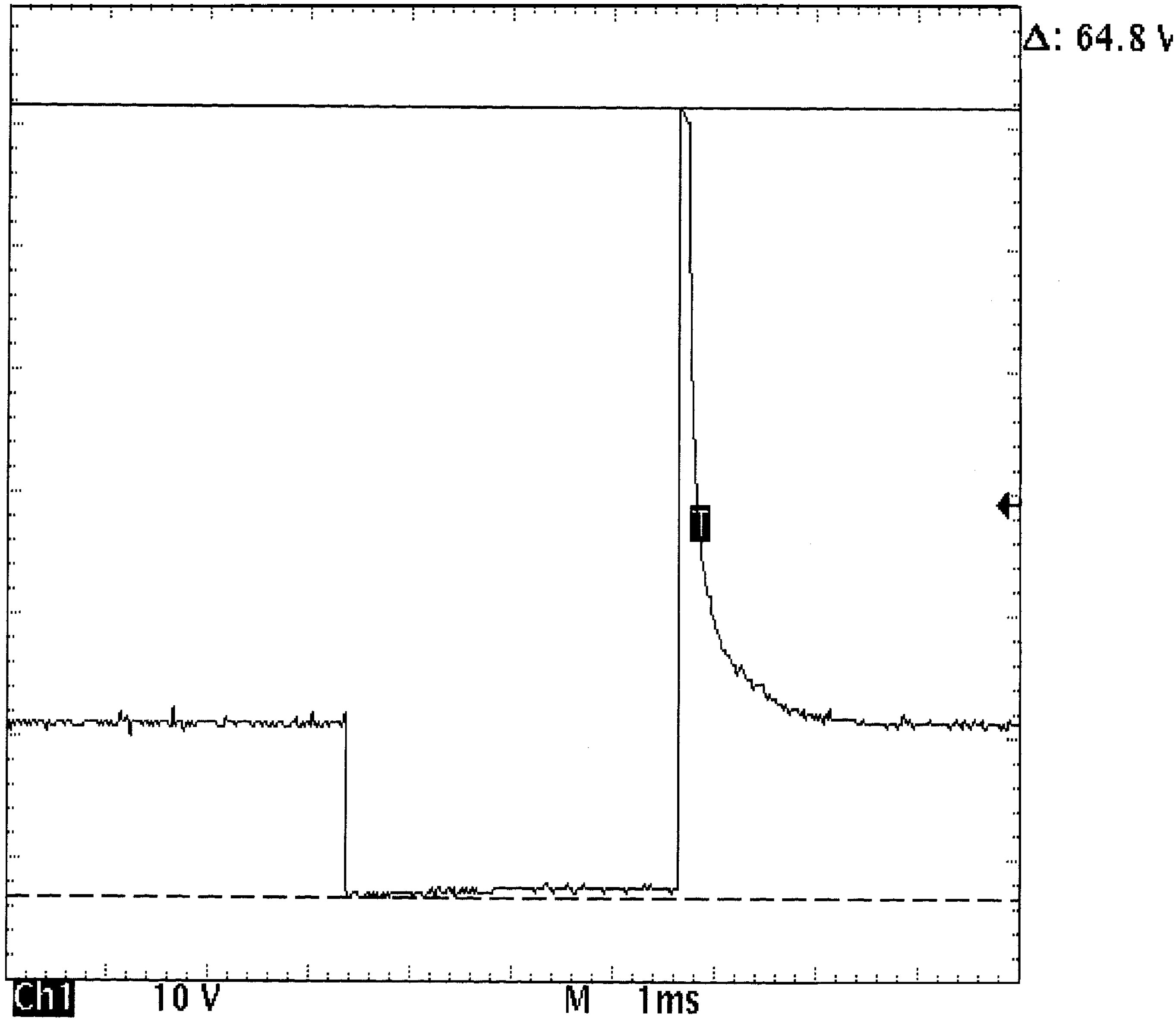


Fig. 17: Single Injector w/Normal Current Flow - Current Pattern

VOLTAGE WAVEFORM SAMPLES

EXAMPLE #1 - VOLTAGE CONTROLLED DRIVER

These two known-good waveform patterns are from a Ford 4.6L V8 VIN [W]. Fig. 18 illustrates the 64 volt inductive kick on this engine, indicating no clamping is occurring. The second pattern, Fig. 19, was taken during hot idle, closed loop, and no load.



95E23857
Fig. 18: Injector Bank - Known Good - Voltage Pattern

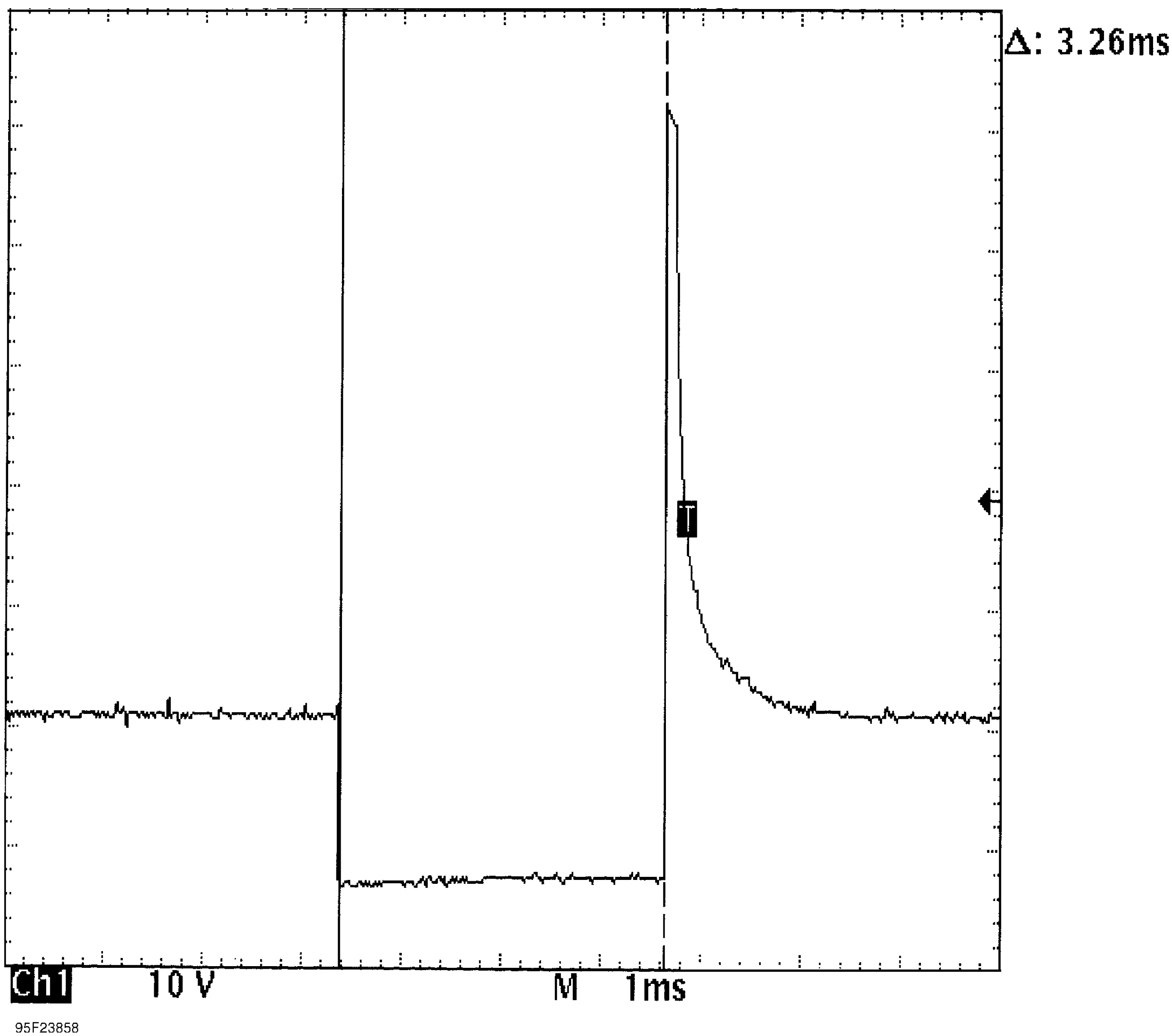


Fig. 19: Injector Bank - Known Good - Voltage Pattern

EXAMPLE #2 - VOLTAGE CONTROLLED DRIVER

The known-good waveform pattern in Fig. 20 is from a GM 3.8L V6 PFI VIN [3]. It was taken during hot idle, closed loop and no load.

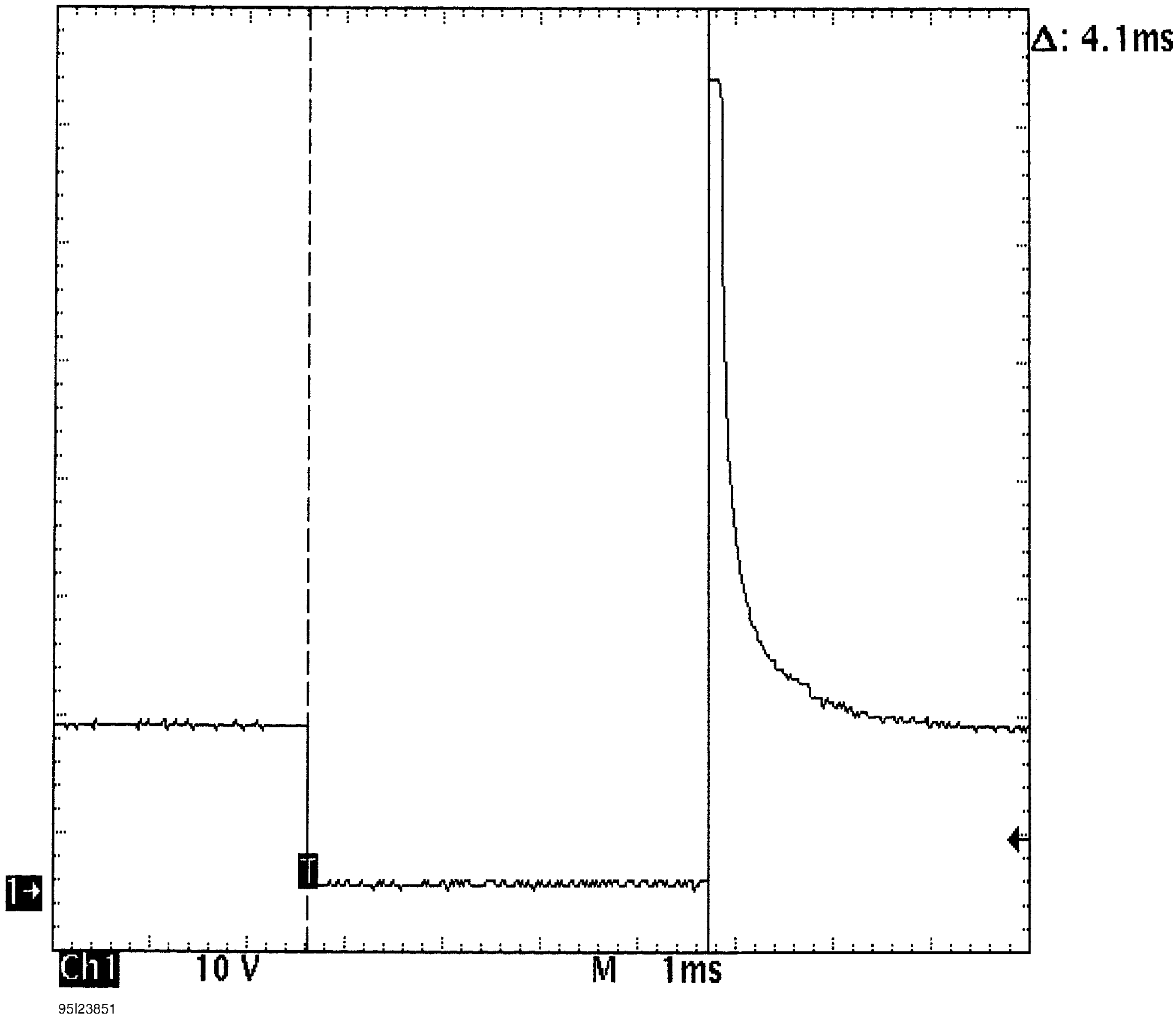
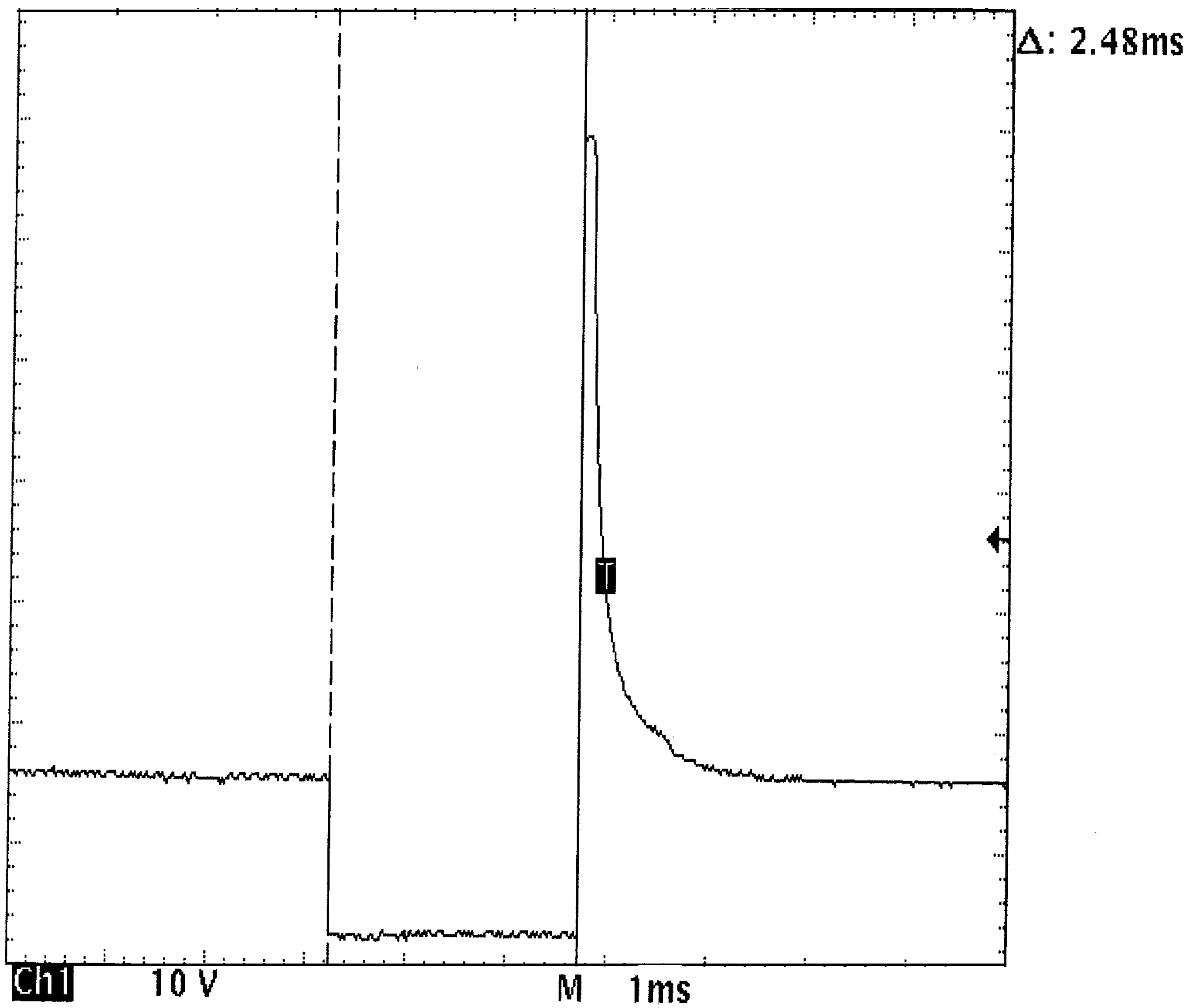


Fig. 20: Injector Bank - Known Good - Voltage Pattern

EXAMPLE #3 - VOLTAGE CONTROLLED DRIVER

This known-good waveform pattern, Fig. 21, is from a GM 5.0L V8 TPI VIN [F]. It was taken during hot idle, closed loop and no load.



95G23859

Fig. 21: Injector Bank - Known Good - Voltage Pattern

EXAMPLE #4 - CURRENT CONTROLLED DRIVER

From 1984 to 1987, Chrysler used this type injector drive on their TBI-equipped engines. See Fig. 22 for a known-good pattern. Instead of the ground side controlling the injector, Chrysler permanently grounds out the injector and switches the power feed side. Most systems do not work this way.

These injectors peak at 6 amps of current flow and hold at 1 amp.

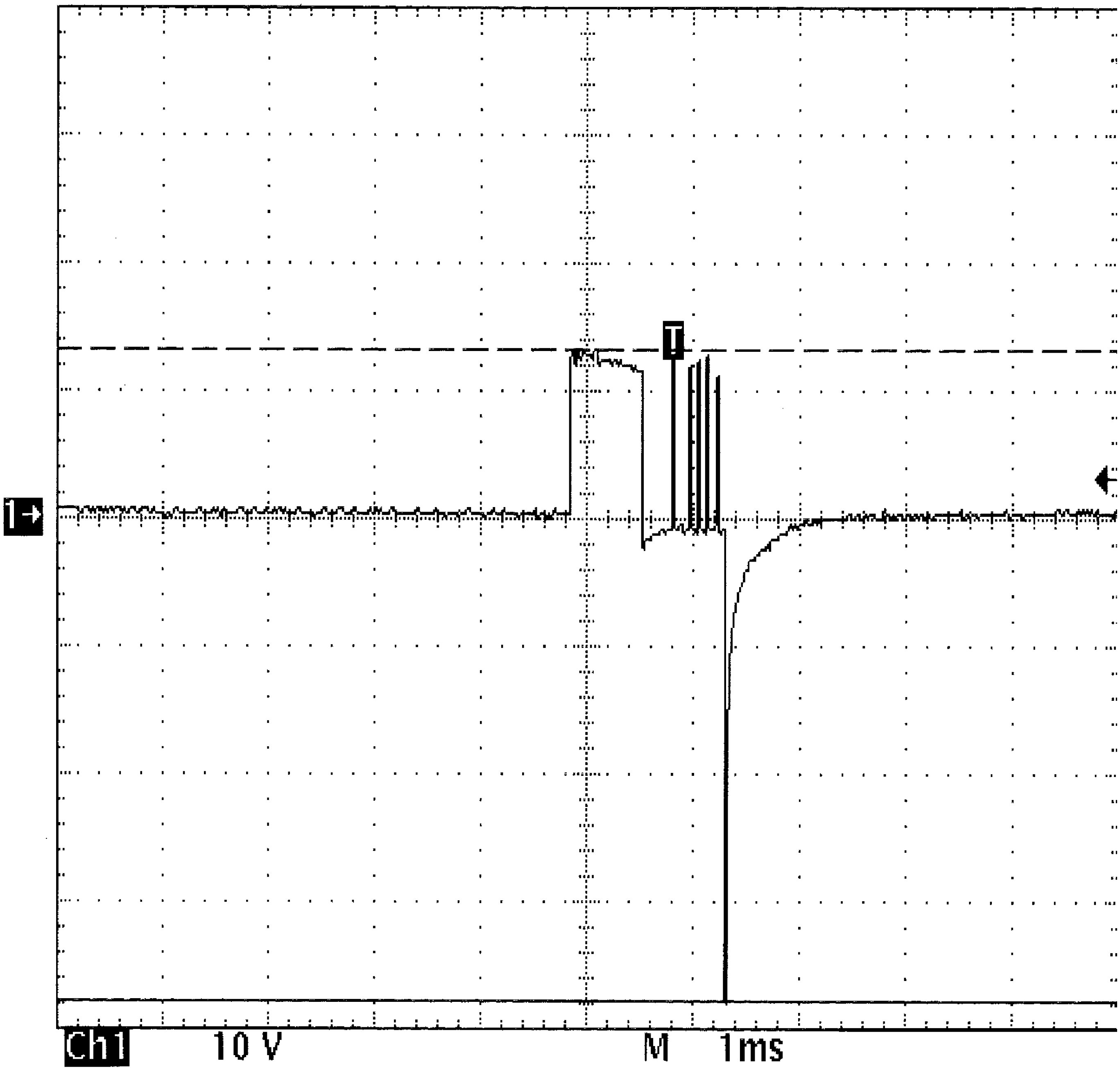


Fig. 22: Single Injector - Known Good - Voltage Pattern

EXAMPLE #5 - CURRENT CONTROLLED DRIVER

These two known-good waveform patterns are from a Chrysler 3.0L V6 VIN [3]. The first waveform, Fig. 23, is a dual trace pattern that illustrates how Chrysler uses the rising edge of the engine speed signal to trigger the injectors. The second waveform, Fig. 24, was taken during hot idle, closed loop, and no load.

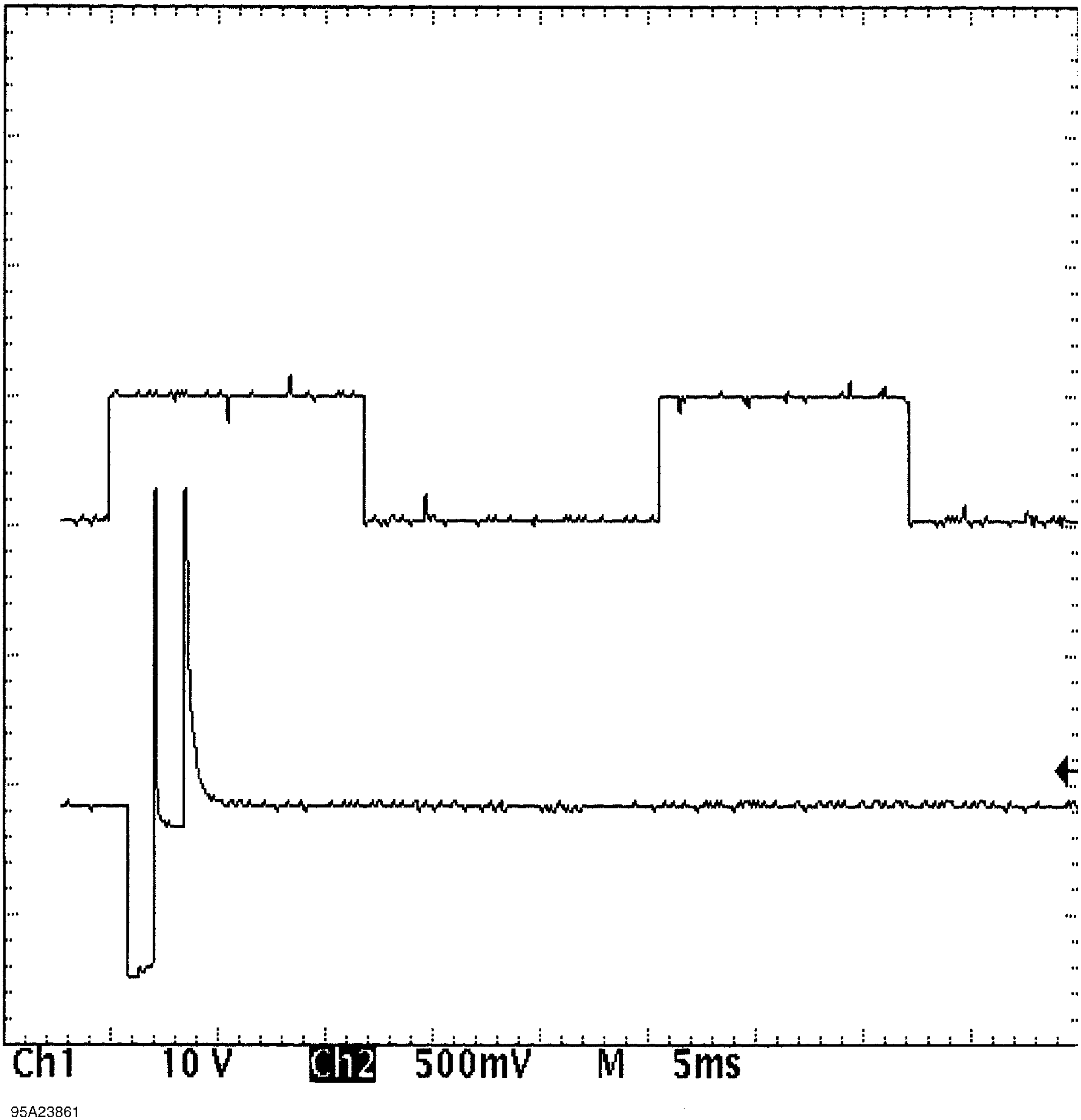


Fig. 23: Injector Bank - Known Good - Voltage Pattern

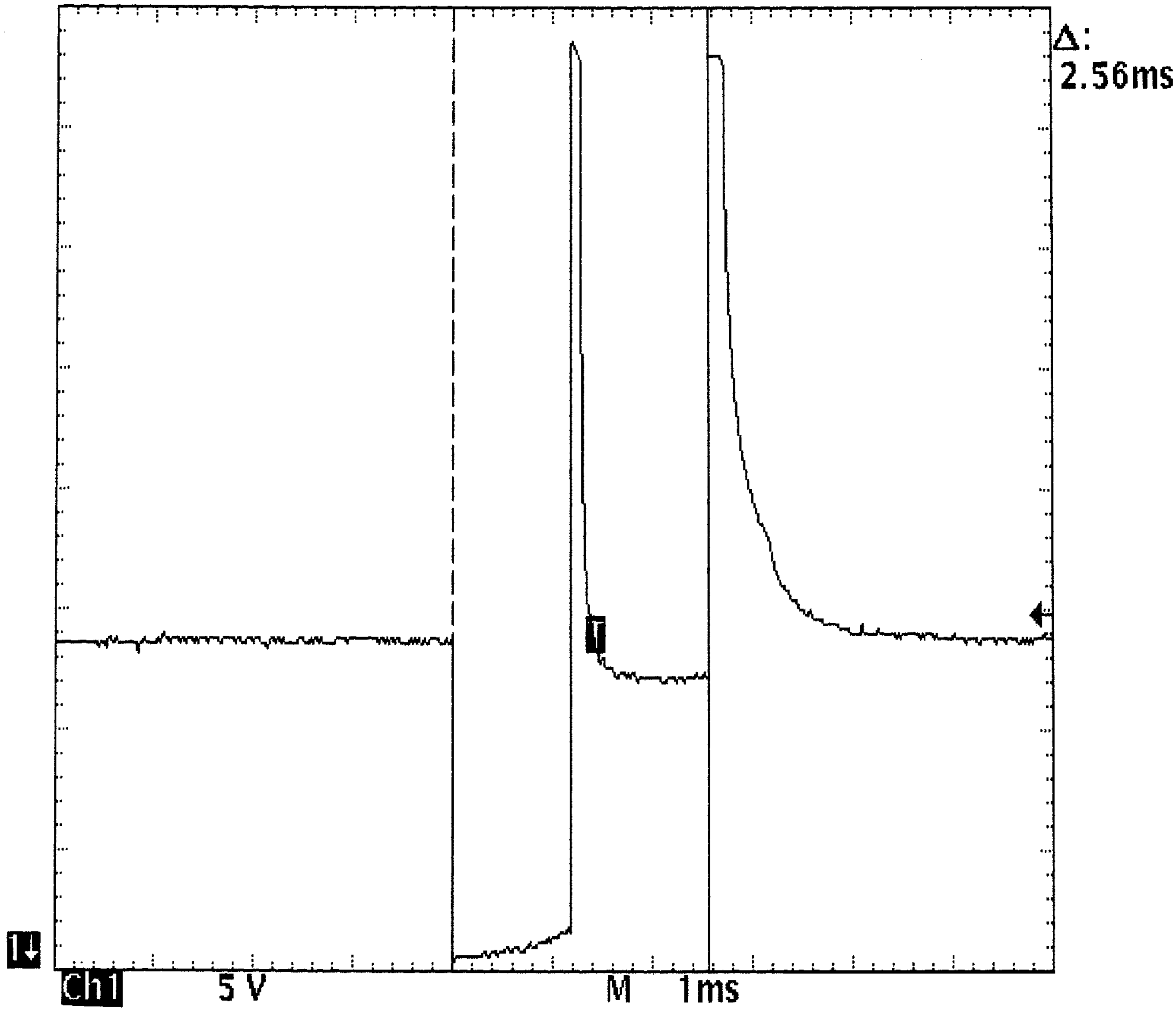


Fig. 24: Injector Bank - Known Good - Voltage Pattern

EXAMPLE #6 - CURRENT CONTROLLED DRIVER

This known-good pattern from a Ford 3.0L V6 PFI VIN [U] illustrates that a zener diode inside the computer is used to clamp the injector's inductive kick to 35-volts on this system. See Fig. 25.

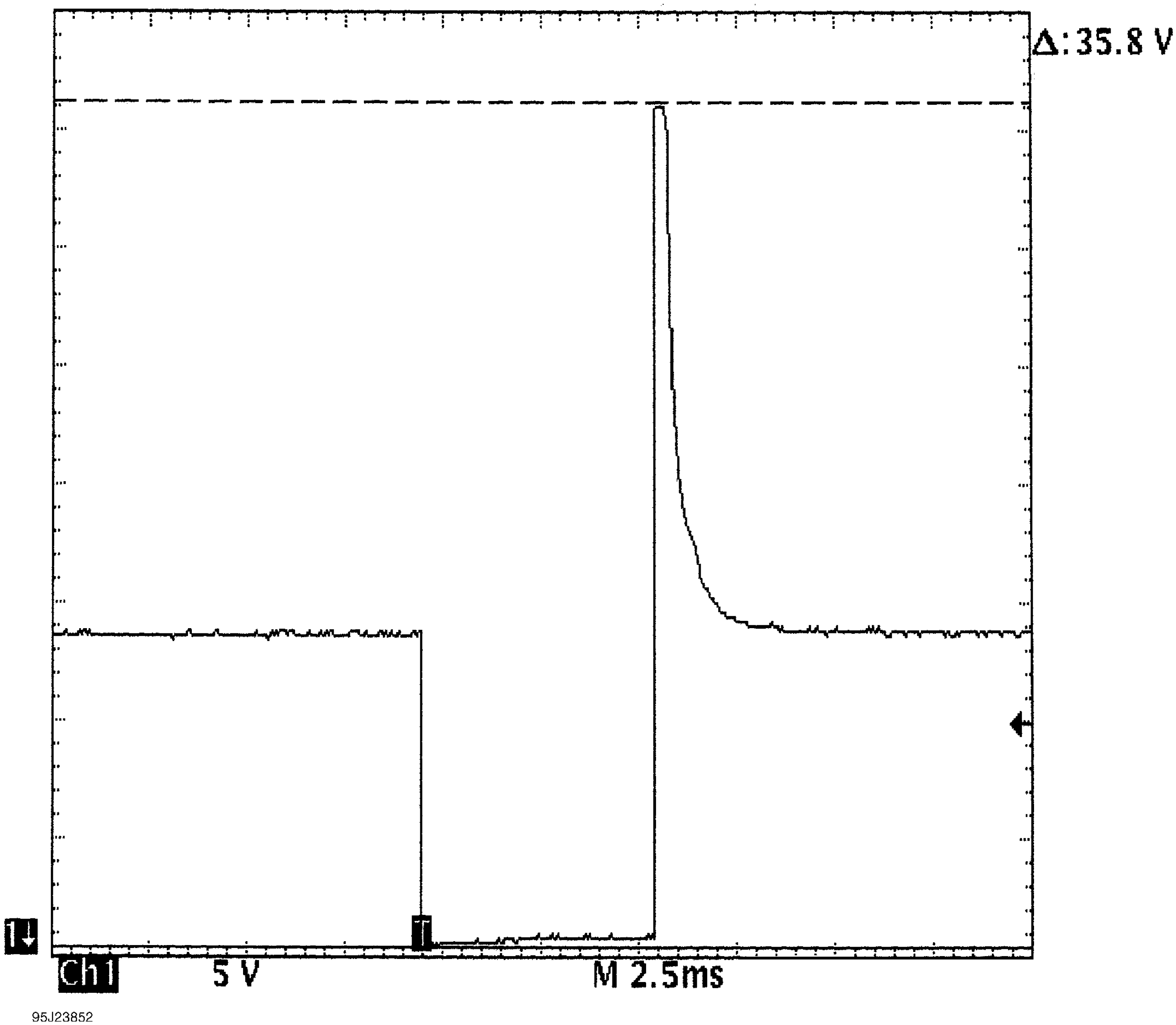


Fig. 25: Injector Bank - Known Good - Voltage Pattern

EXAMPLE #7 - CURRENT CONTROLLED DRIVER

This known-good waveform from a Ford 5.0L V8 CFI VIN [F] was taken during hot idle, closed loop, and no load. See Fig. 26.

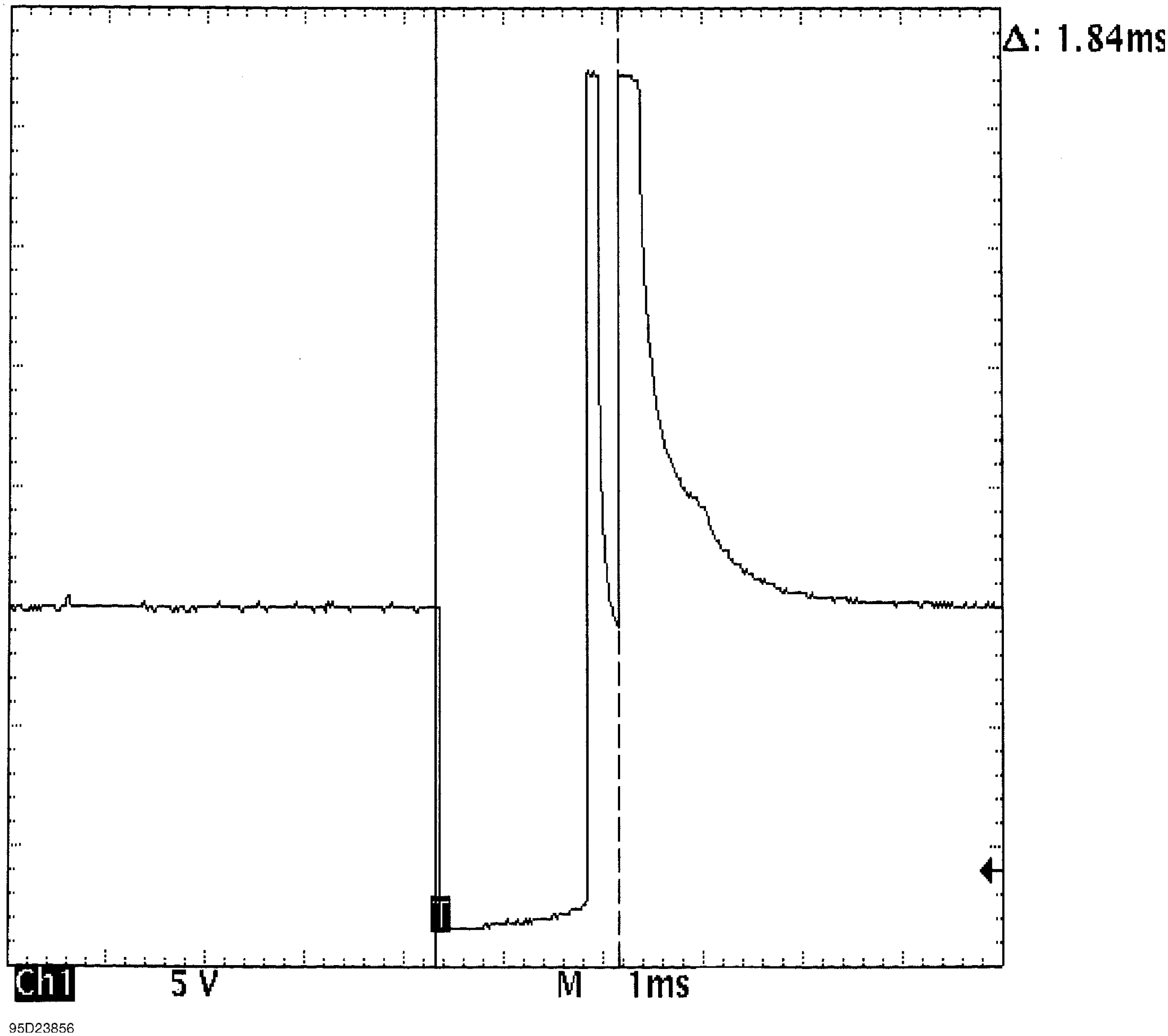


Fig. 26: Single Injector - Known Good - Voltage Pattern

EXAMPLE #8 - CURRENT CONTROLLED DRIVER

These two known-good waveform patterns are from a GM 2.0L In-Line 4 VIN [1]. Fig. 27 illustrates the 78 volt inductive spike that indicates a zener diode is not used. The second waveform, Fig. 28, was taken during hot idle, closed loop, and no load.

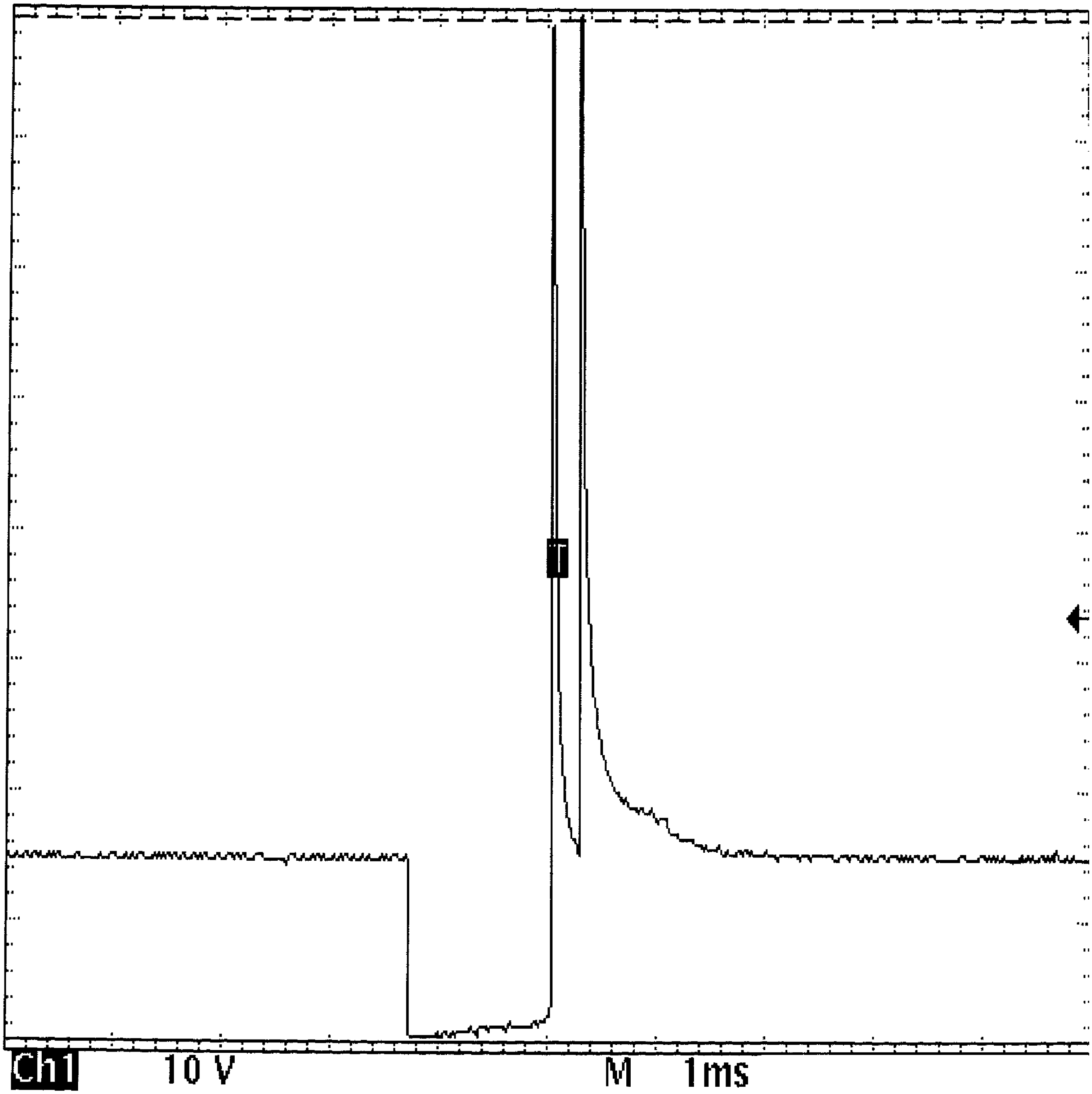


Fig. 27: Single Injector - Known Good - Voltage Pattern

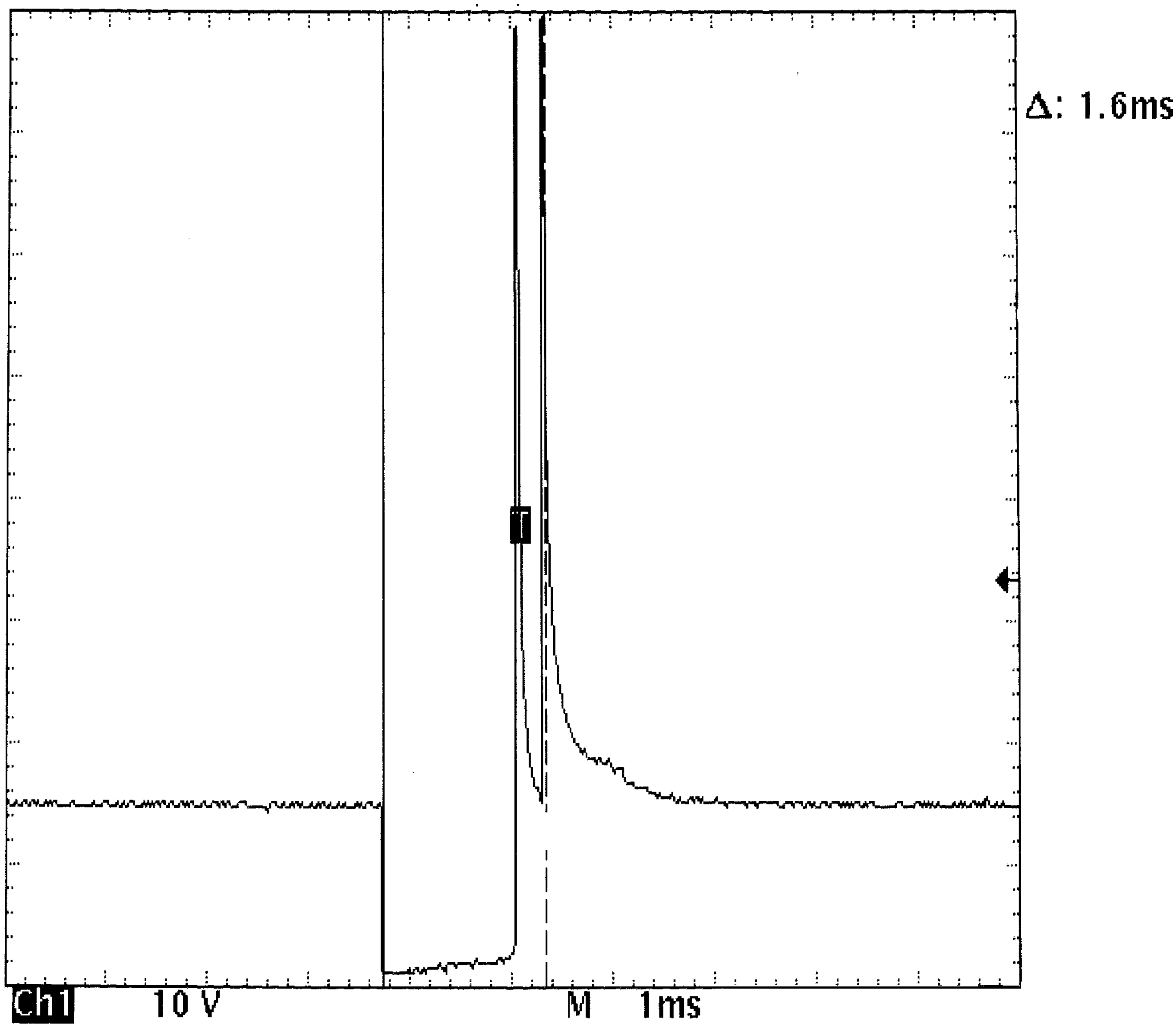


Fig. 28: Single Injector - Known Good - Voltage Pattern

WHEEL ALIGNMENT SPECIFICATIONS & PROCEDURES

1988 Jeep Cherokee

1988 Wheel Alignment
INTRODUCTION

PRE-ALIGNMENT

VEHICLE CHECKS

Prior to making wheel alignment adjustments, check and adjust the following items:

1) Tire pressure must be inflated to manufacturers recommended specifications.Tires should be equal in size and type. Runout must not be excessive. Tires and wheels should be in balance.

2) Wheel bearings must be properly adjusted. Steering linkage and suspension must not have excessive wear and/or looseness. Check for wear in tie rod ends and ball joints.

3) Steering gear box must not have excessive play. Check and adjust to manufacturer's specifications.

4) Vehicle must be at correct ride height with full fuel load and spare tire in vehicle. No extra load should be on vehicle.

5) Vehicle must be level with floor and with suspension settled. Jounce front and rear of vehicle several times and allow it to settle to normal ride height.

6) Ensure steering wheel spokes are centered with front wheels in straight-ahead position, correct by shortening one tie rod adjusting sleeve and lengthening opposite sleeve equal amounts.

7) Ensure wheel lug nuts are tightened to torque specifications.

DESCRIPTION

CAMBER

Camber is the inward or outward tilt of the wheel as viewed from front of vehicle. Camber is measured from centerline of vehicle. When wheel is tilted outward at top from centerline of vehicle, camber is positive. When wheel is tilted inward at top from centerline of vehicle, camber is negative. Camber is measured in degrees from vertical.

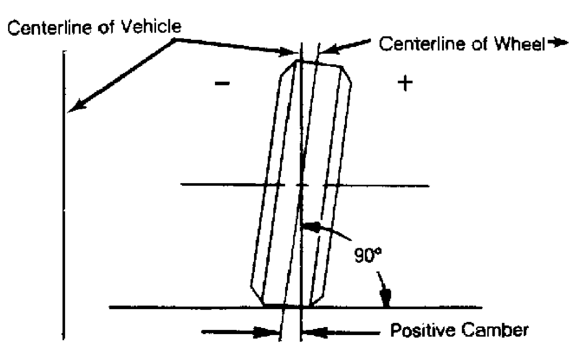


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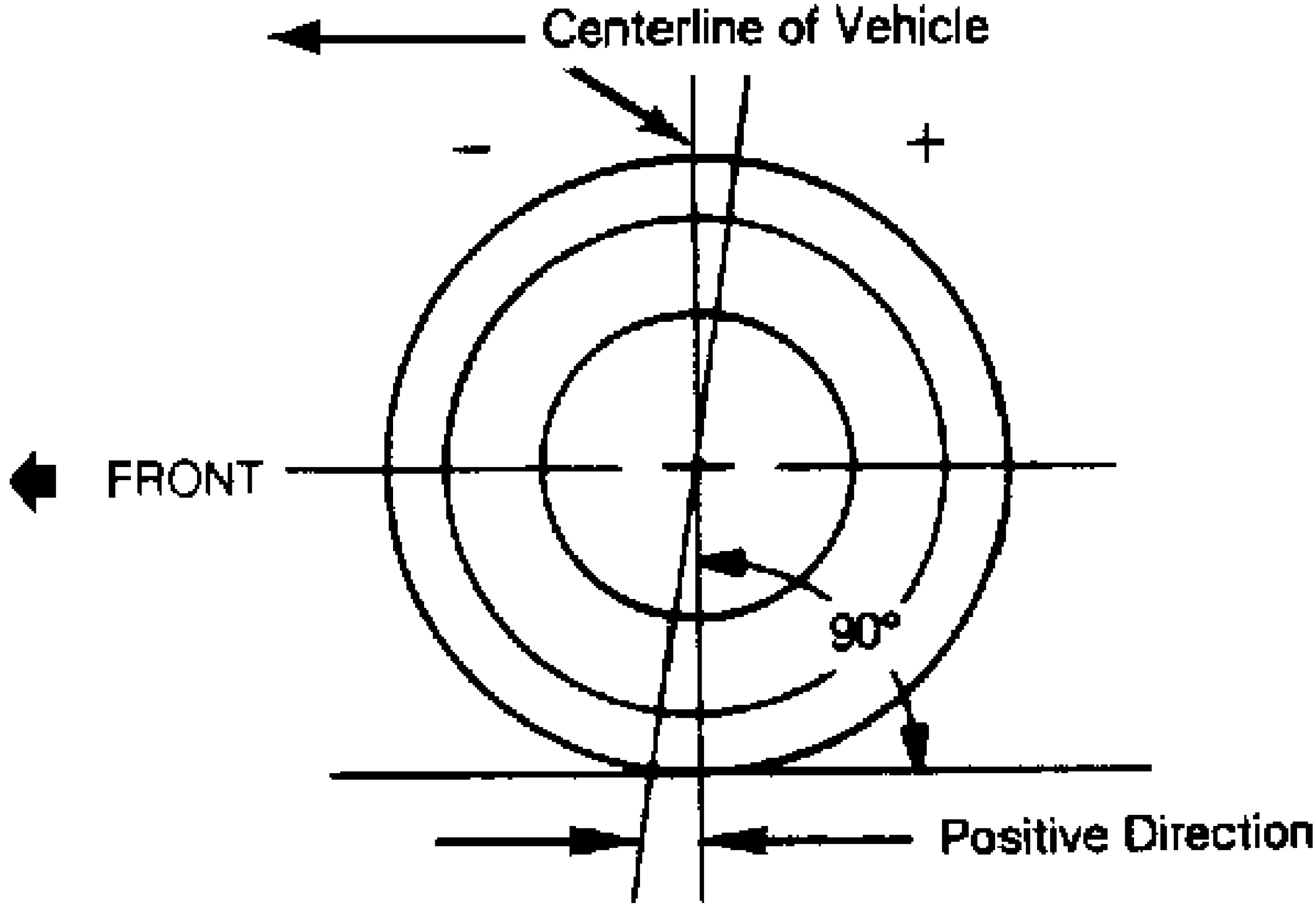
Fig. 1: Camber Angle

CASTER

Caster is the tilting of front steering axis. This forward

or backward tilt from vertical is viewed from side of vehicle. When axis is tilted backward from vertical, caster is said to be positive, creating a trailing action on front wheels. When axis is tilted forward, caster is negative, causing a leading action on front wheels.



30410

Fig. 2: Caster Angle

TOE

Toe is the measured difference in inches of distance between the front edge of the tires and the rear edge of the tires at spindle height. Toe can be measured in inches or degrees.

ADJUSTMENT

TOE

1) Measure toe with front wheels straight-ahead and steering wheel locked in a centered position. Adjust toe by loosening clamps and adjusting sleeve or adjusting ends on right and left tie rods equally and in opposite directions to maintain steering wheel in centered position.

2) If steering wheel is not centered to begin with, determine which tire assembly is toed in or out more than the other

and compensate adjustment more to that side to center steering wheel. A couple of tries will probably be necessary to properly center steering wheel.

3) When tightening clamps, make sure that clamp bolts are positioned so there will be no interference with other parts throughout entire travel of steering linkage.

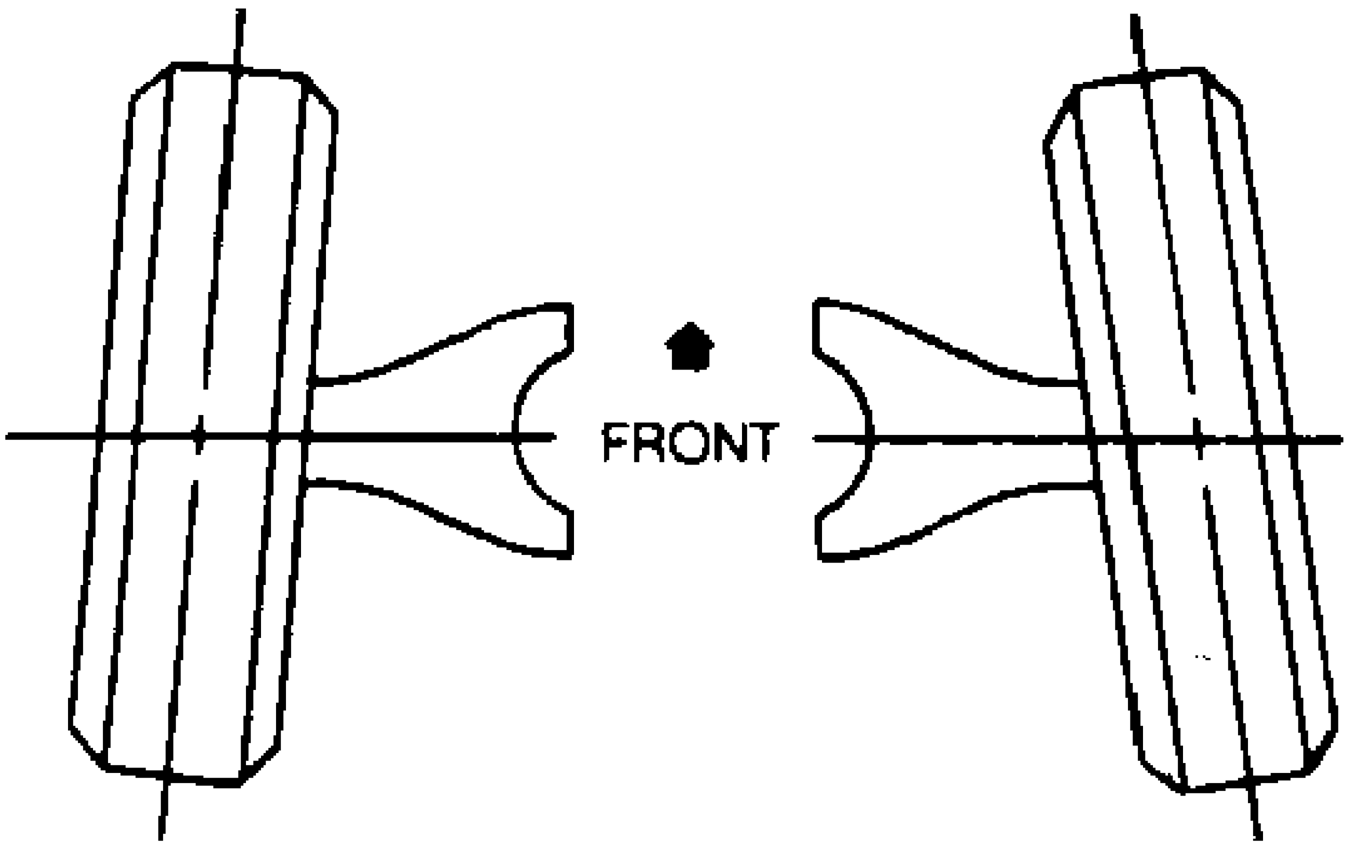


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Fig. 3: Wheel Toe
To adjust, turn sleeves an equal amount in opposite directions.

TOE-OUT ON TURNS

1) This is a check for bent or damaged parts, and not a service adjustment. With caster, camber and toe-in properly adjusted, check toe-out with weight of vehicle on wheels.

2) Use full-floating turn table under each wheel. Turn left wheel in 20 degrees on scale of turn table and read scale of turn table on right wheel. Reading should be within 2 degrees of left wheel. Repeat test for right wheel.

3) Incorrect readings of toe-out generally indicates a bent steering arm. Replace arm and recheck wheel alignment adjustments. Do not attempt to correct by straightening parts.

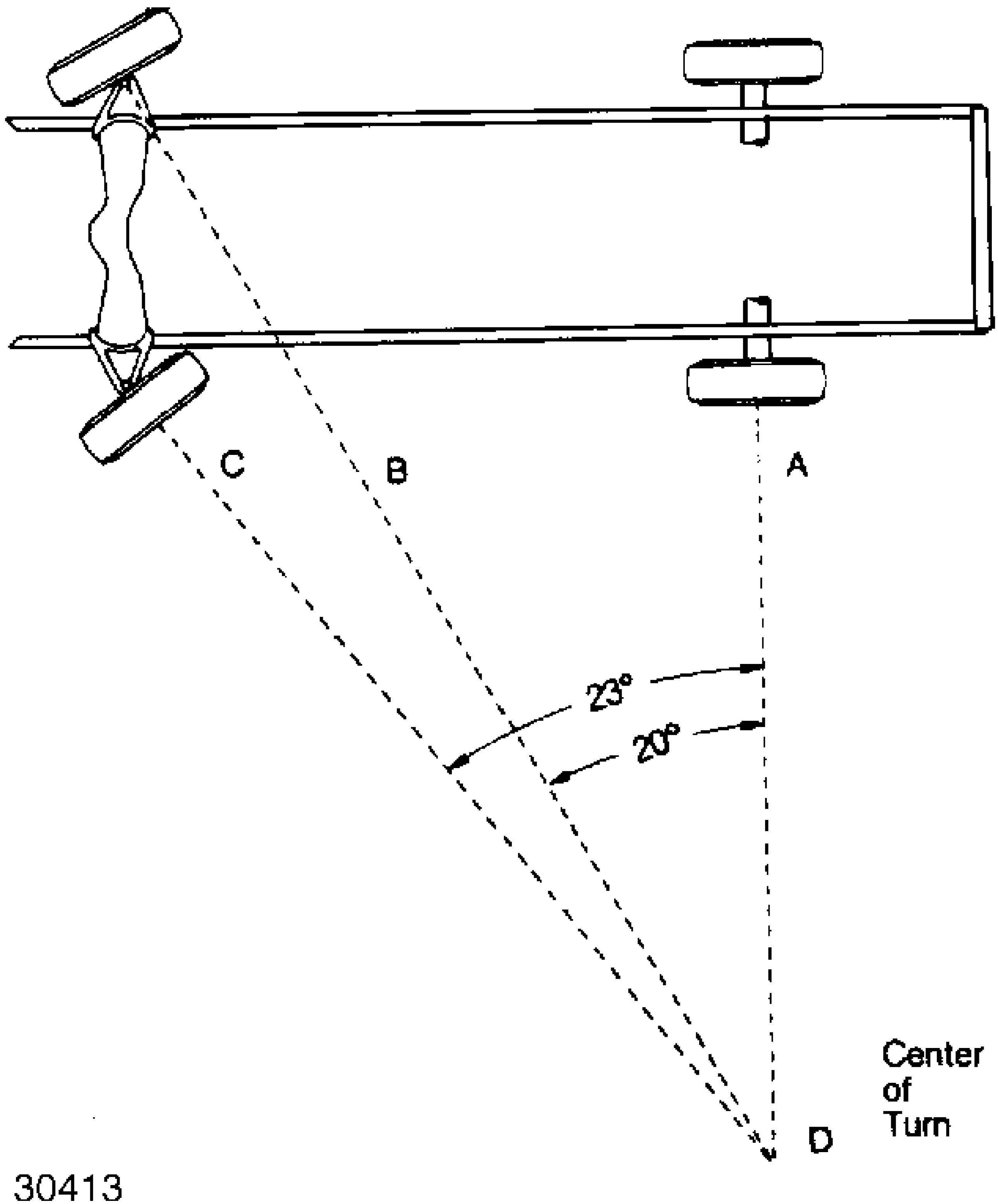

Fig. 4: Wheel Toe-Out on Turns

STEERING AXIS INCLINATION

1) This is a check for bent or damaged parts, and not a

service adjustment. Vehicle must be level, both crosswise and lengthwise. Camber should be properly adjusted.

2) If camber cannot be brought within limits and steering axis inclination is correct, steering knuckle is bent. If camber and steering axis inclination are both incorrect by approximately the same amount, upper and lower control arms are bent.

3) Replace parts and recheck all wheel alignment adjustments. Do not attempt to correct by straightening parts.

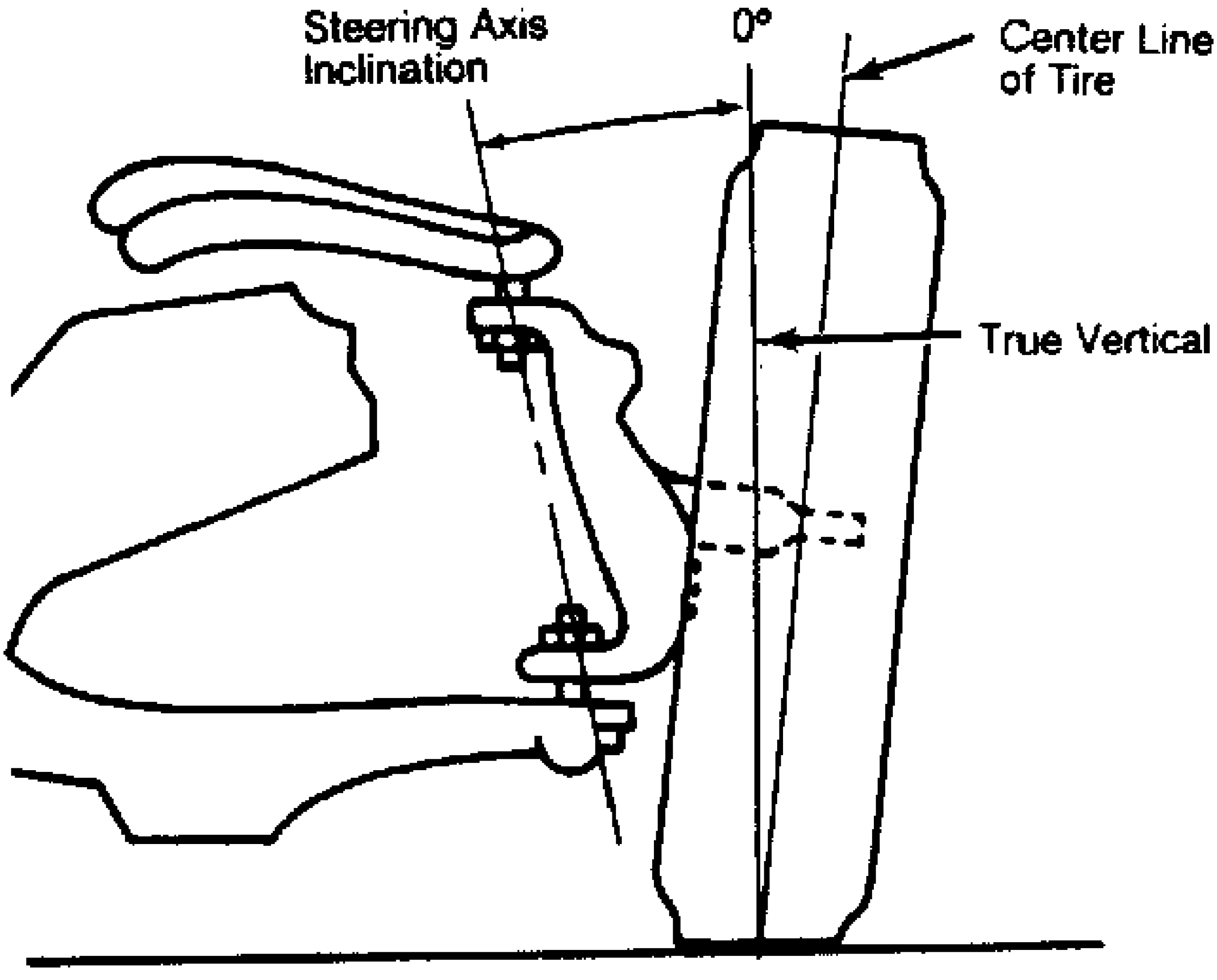

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Fig. 5: Steering Axis Inclination

TORQUE SPECIFICATIONS

WHEEL LUG NUT TORQUE SPECIFICATIONS TABLE

Application	Ft. Lbs. (N.m)
Grand Wagoneer	85 (115)
All Other Models	75 (102)

ALIGNMENT SPECIFICATIONS

WHEEL ALIGNMENT SPECIFICATIONS TABLE

Application	Specification
Cherokee, Comanche, Wrangler & Wagoneer	
Ride Height in Inches	.....
Adjustment Procedures	.....
Camber in Degrees (Fraction)	-1/2 to 1/2
Camber in Degrees (Decimal)	-0.50 to 0.50
Caster in Degrees (Fraction)	7 to 8
Caster in Degrees (Decimal)	7.0 to 8.0
Toe-In in Inches (Fraction)	1/32 to 1/32
Toe-In in Inches (Decimal)	0.031 to 0.031
Toe-In in Degrees (Fraction)	1/16 to 1/16
Toe-In in Degrees (Decimal)	0.063 to 0.063
Toe-Out on Turns	
Inner	NS
Outer	NS
Steering Axis Inclination (SAI)	8 1/2°
Grand Wagoneer	
Ride Height in Inches	.....
Adjustment Procedures	.....
Camber in Degrees (Fraction)	0 to 1/2
Camber in Degrees (Decimal)	0 to 0.5
Caster in Degrees (Fraction)	4 to 5
Caster in Degrees (Decimal)	4.0 to 5.0
Toe-In in Inches (Fraction)	3/64 to 3/32
Toe-In in Inches (Decimal)	0.047 to 0.094
Toe-In in Degrees (Fraction)	3/32 to 3/16
Toe-In in Degrees (Decimal)	0.094 to 0.188
Toe-Out on Turns	
Inner	NS
Outer	NS
Steering Axis Inclination (SAI)	8 1/2°

NS - Information not available from manufacturer.

RIDING HEIGHT SPECIFICATIONS

Inflate tires to proper air pressure. Specifications can be found on door pillar or in glove box. Cargo compartment must by empty. Fuel tank should be full. Bounce vehicle up and down to normalize ride height. Ride height specifications in regard to setting camber and caster are not provided by the manufacturer.

WHEEL ALIGNMENT THEORY/OPERATION

1988 Jeep Cherokee

GENERAL INFORMATION
Wheel Alignment Theory & Operation

ALL MODELS

* PLEASE READ THIS FIRST *

NOTE: This article is intended for general information purposes only. This information may not apply to all makes and models.

PRE-ALIGNMENT INSTRUCTIONS

GENERAL ALIGNMENT CHECKS

Before adjusting wheel alignment, check the following:

* Each axle uses tires of same construction and tread style, equal in tread wear and overall diameter. Verify that radial and axial runout is not excessive. Inflation should be at manufacturer's specifications.
* Steering linkage and suspension must not have excessive play. Check for wear in tie rod ends and ball joints. Springs must not be sagging. Control arm and strut rod bushings must not have excessive play. See Fig. 1.

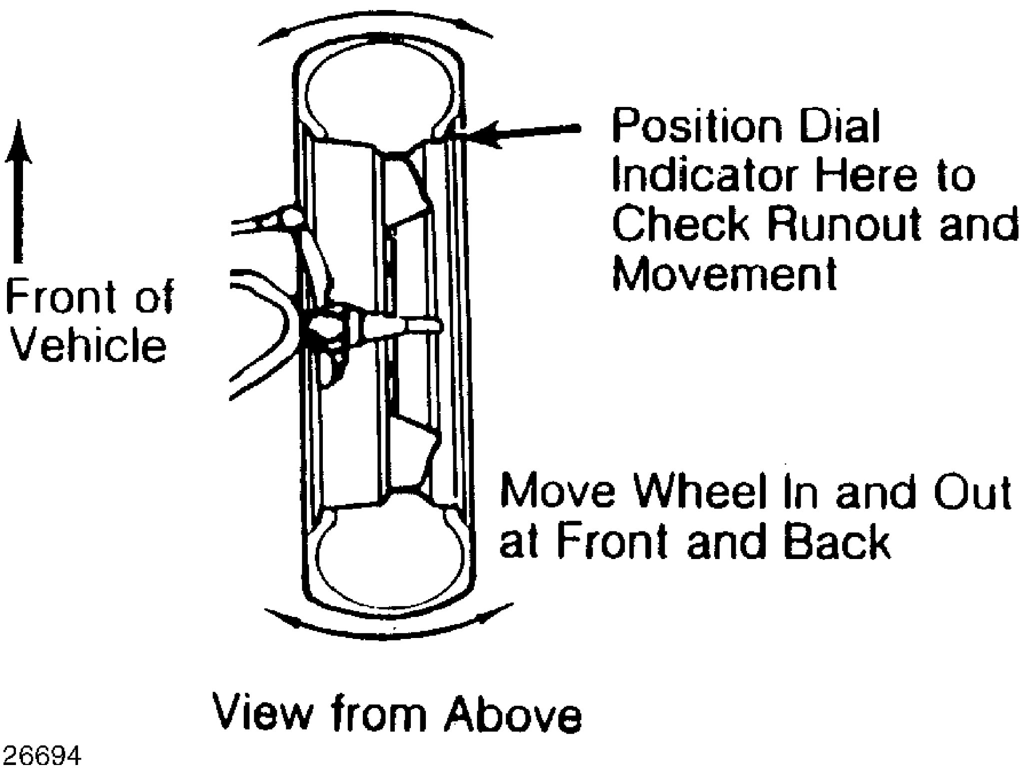

Fig. 1: Checking Steering Linkage

* Vehicle must be on level floor with full fuel tank, no passenger load, spare tire in place and no load in trunk. Bounce front and rear end of vehicle several times. Confirm

vehicle is at normal riding height.

* Steering wheel must be centered with wheels in straight ahead position. If required, shorten one tie rod adjusting sleeve and lengthen opposite sleeve (equal amount of turns). See Fig. 2.
* Wheel bearings should have the correct preload and lug nuts must be tightened to manufacturer's specifications. Adjust camber, caster and toe-in using this sequence. Follow instructions of the alignment equipment manufacturer.

CAUTION: Do not attempt to correct alignment by straightening parts. Damaged parts must be replaced.

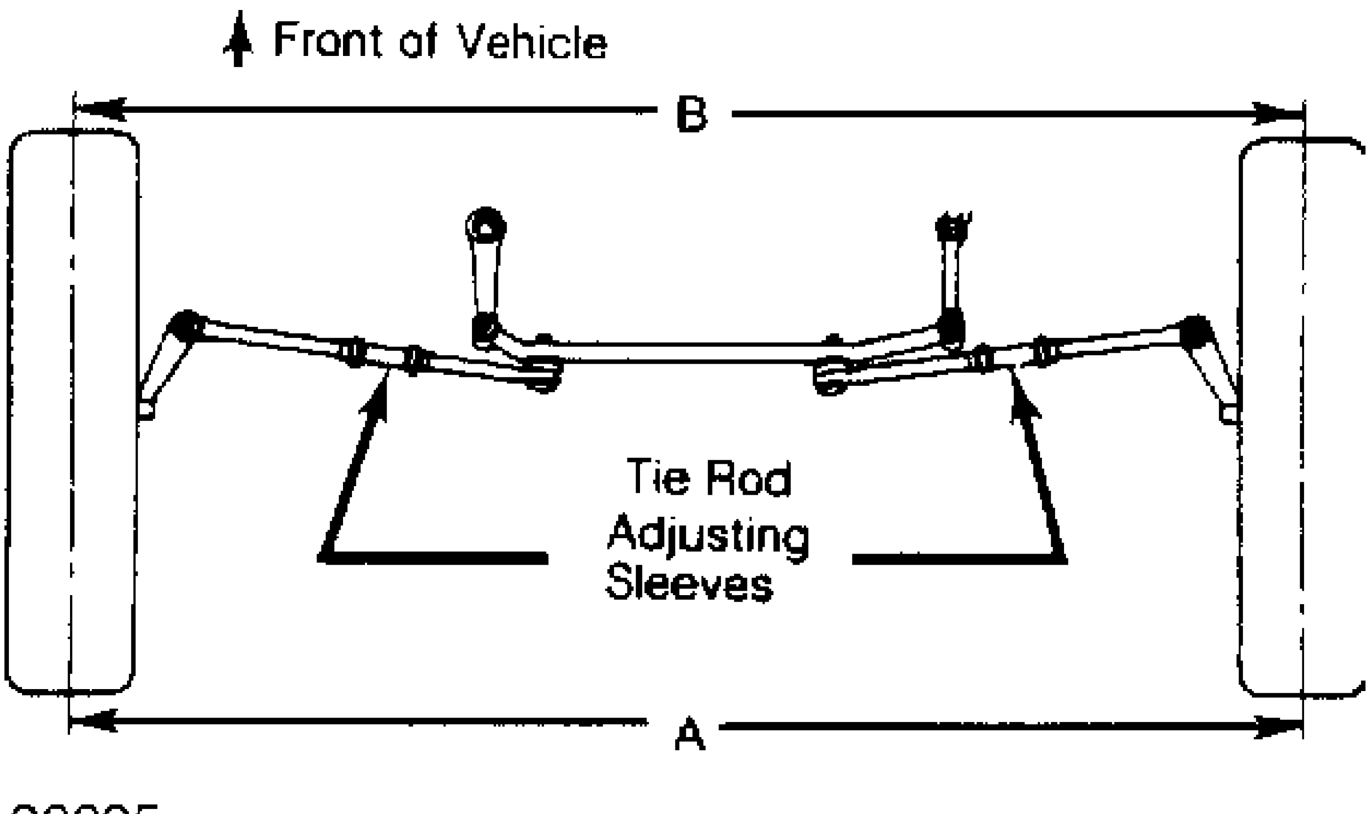

Fig. 2: Adjusting Tie Rod Sleeves (Top View)

CAMBER

1) Camber is the tilting of the wheel, outward at either top or bottom, as viewed from front of vehicle. See Fig. 3.

2) When wheels tilts outward at the top (from centerline of vehicle), camber is positive. When wheels tilt inward at top, camber is negative. Amount of tilt is measured in degrees from vertical.

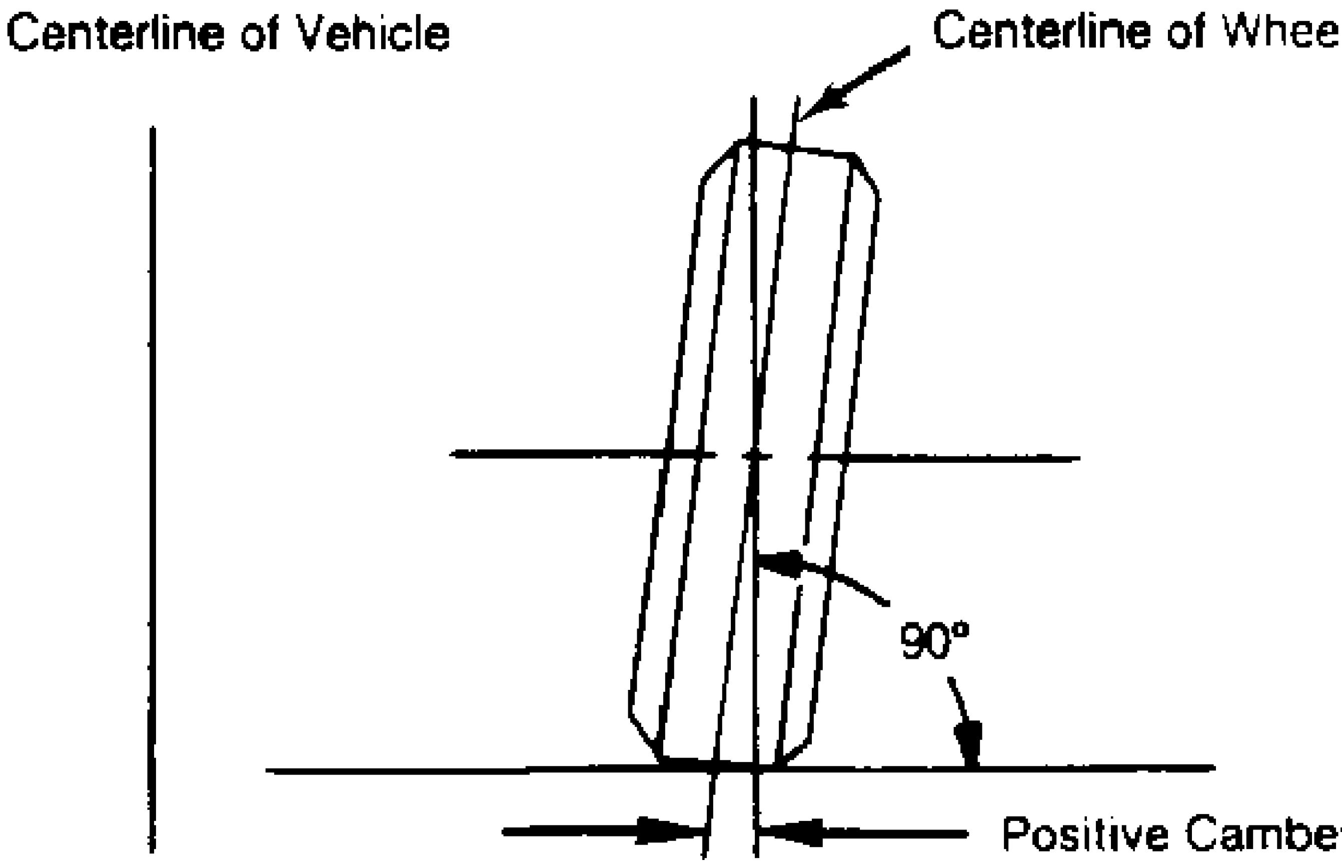

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Fig. 3: Determining Camber Angle

CASTER

1) Caster is tilting of front steering axis either forward or backward from vertical, as viewed from side of vehicle. See Fig. 4.

2) When axis is tilted backward from vertical, caster is positive. This creates a trailing action on front wheels. When axis is tilted forward, caster is negative, causing a leading action on front wheels.

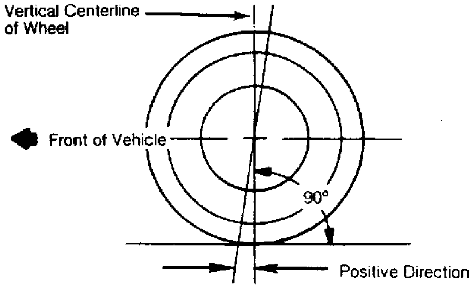

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Fig. 4: Determining Caster Angle

TOE-IN ADJUSTMENT

Toe-in is the width measured at the rear of the tires

subtracted by the width measured at the front of the tires at about spindle height. A positive figure would indicate toe-in and a negative figure would indicate toe-out. If the distance between the front and rear of the tires is the same, toe measurement would be zero. To adjust:

1) Measure toe-in with front wheels in straight ahead position and steering wheel centered. To adjust toe-in, loosen clamps and turn adjusting sleeve or adjustable end on right and left tie rods. See Figs. 2 and 5.

2) Turn equally and in opposite directions to maintain steering wheel in centered position. Face of tie rod end must be parallel with machined surface of steering rod end to prevent binding.

3) When tightening clamps, make certain that clamp bolts are positioned so there will be no interference with other parts throughout the entire travel of linkage.

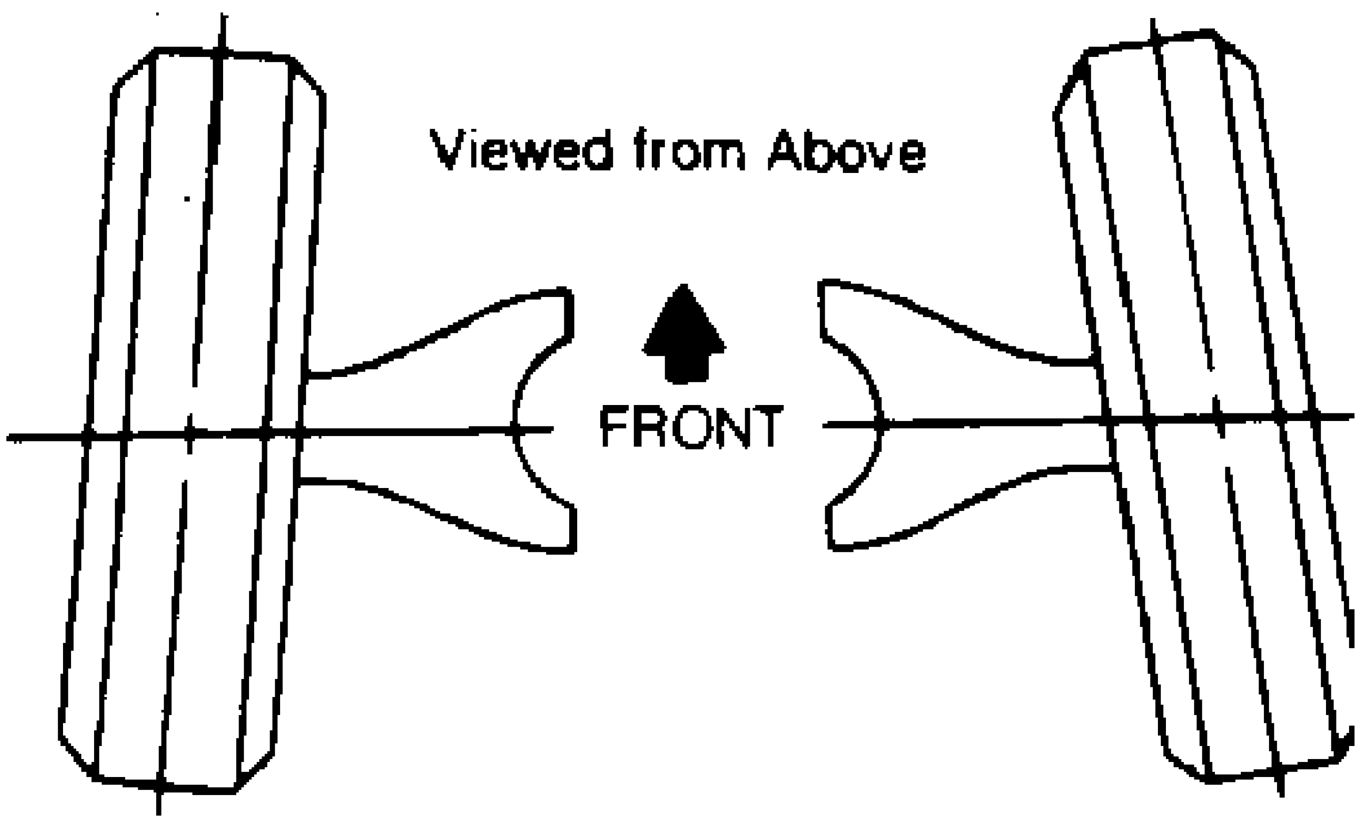

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Fig. 5: Wheel Toe-In (Dimension A Less Dimension B)

TOE-OUT ON TURNS

1) Toe-out on turns (turning radius) is a check for bent or damaged parts, and not a service adjustment. With caster, camber, and toe-in properly adjusted, check toe-out with weight of vehicle on wheels.

2) Use a full floating turntable under each wheel, repeating test with each wheel positioned for right and left turns. Incorrect toe-out generally indicates a bent steering arm. Replace arm, if necessary, and recheck wheel alignment.

STEERING AXIS INCLINATION

1) Steering axis inclination is a check for bent or damaged parts, and not a service adjustment. Vehicle must be level and camber should be properly adjusted. See Fig. 6.

2) If camber cannot be brought within limits and steering axis inclination is correct, steering knuckle is bent. If camber and steering axis inclination are both incorrect by approximately the same amount, the upper and lower control arms are bent.

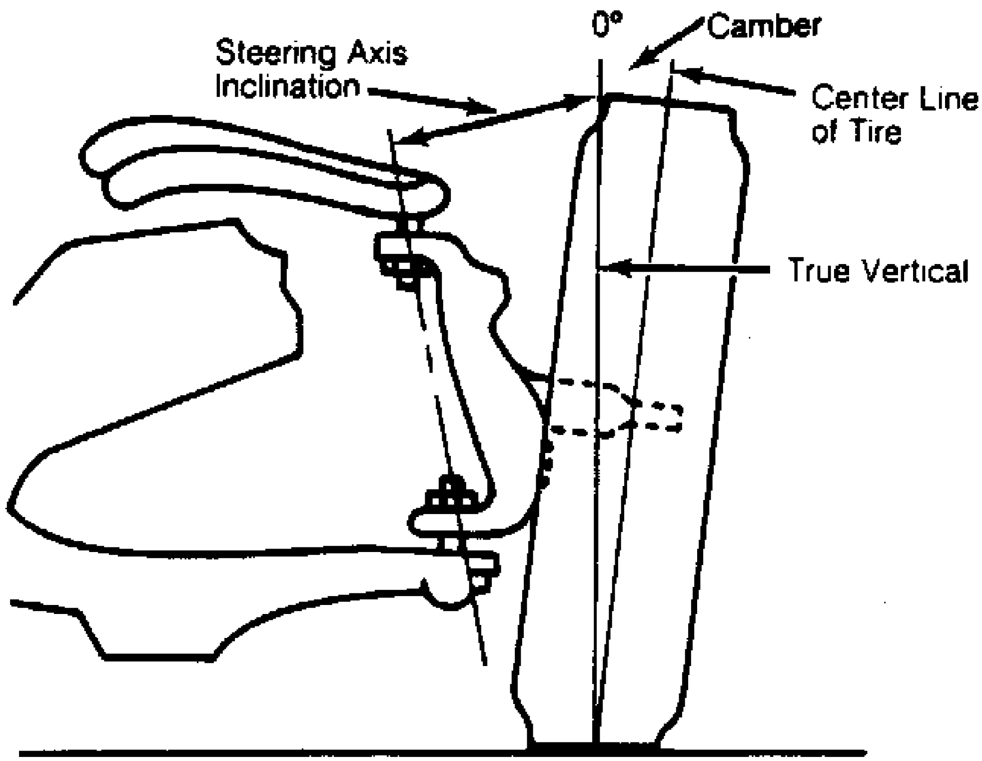


Fig. 6: Checking Steering Axis Inclination

WIPER/WASHER SYSTEM

1988 Jeep Cherokee

1988 Wiper/Washer Systems
JEEP

All Models

DESCRIPTION

Jeep vehicles use a 2-speed electric motor, which is a compound wound (series and shunt) type. A crank arm, attached externally to gear shaft, operates linkage which activates wiper blades.

All models have an optional intermittent feature. All models use an electric washer system consisting of a motor, reservoir, and necessary hoses and nozzles.

Some Cherokee and Wagoneer models are equipped with rear wipers. The rear motor is a single-speed motor with an automatic park feature. The circuit is protected by a separate 4.5-amp circuit breaker attached to brake pedal support.

TROUBLE SHOOTING

WIPER INOPERATIVE OR OPERATES AT ONE SPEED ONLY

1) If wiper does not operate on either speed, check for binding or interference of linkage. If okay, place wiper switch on "LO" and then on "HI" setting. Connect a test light between terminals of wiring harness plug that connects to motor.

2) Check for power at White wire with tracer and Black (ground) wire terminal for low speed. Check between Dk. Blue with tracer and Black wire terminal for high speed.

3) If light does not glow, check ignition switch, wiper switch, harness or terminals for open circuits. If light glows, check for loose or misaligned connection between wiring harness plug and motor plug. If okay, replace wiper motor.

WIPERS DO NOT PARK

1) Disconnect motor and connect Gray lead to White lead. Apply 12 volts to Blue lead. Replace motor if it fails to park. If it parks, turn ignition switch on, and wiper switch to "PARK".

2) Connect a test light to Lt. Green wire with tracer and to ground at motor plug.

3) Check continuity between Tan wire with tracer and White wire with tracer.

4) If test light does not glow, check harness connections between motor and instrument panel switch. If okay, replace panel switch. If not okay, repair harness connection.

WIPER MOTOR QUITS WHILE WIPING

1) With engine idling and blower motor on high, operate wipers at high speed setting for 5 cycles consisting of 3 seconds of water and 57 seconds of drying.

2) If motor struggles to a complete stop, clean glass and replace blades. Repeat test. If motor stops, test circuit breaker in panel switch. If motor stopped suddenly in original test, check circuit breaker. Repeat test. If motor stops, replace motor.

ALL FUNCTIONS OKAY EXCEPT INTERMITTENT WIPE

1) If blades stop and start erratically, test circuit breaker. If okay, check wiper switch continuity. If continuity is present, check continuity of wiring between switch, governor and ground. Repair wiring or replace governor as necessary.

2) If operation is intermittent on low speed only, check for loose connections at governor by disconnecting governor and connecting switch directly to instrument panel harness.

3) If all functions except pulse and mist work, replace governor. If functions are not okay, recheck wiring and replace governor.

WINDSHIELD WASHER DOES NOT OPERATE

1) If motor runs but does not pump, check fluid level. If level is okay, check for split, loose, pinched or kinked hoses. Check for restrictions at nozzles. Check for reversed wire leads to motor.

2) If motor does not run, check for blown fuse. Replace fuse, if necessary. If fuse is okay, disconnect plug at reservoir and check for power by connecting a test light across connector terminals. Energize washer circuit by closing washer and ignition switches.

3) If no power is present, check for open ground wire or defective wiper/washer switch. Repair or replace as necessary. If power is present, reconnect plug to motor and check for tight connection. If motor does not run, replace pump motor.

REMOVAL & INSTALLATION

REAR WIPER SWITCH

Removal & Installation

Remove instrument panel bezel and switch housing panel. Disconnect switch connector, slightly depress switch mounting tabs and remove switch. To install, reverse removal procedure.

REAR WIPER MOTOR

Removal & Installation

1) Remove wiper arm from pivot pin by depressing tab and pulling arm straight out. Disconnect washer hose. Remove pivot pin retaining nut and interior trim panel. Remove rear wiper motor attaching screws and remove wiper motor.

2) To install, reverse removal procedure. Wiper blade should be parallel to window in parked position (3/8-3/4" from bottom of window) and come no closer than 3/16" to window seal when operated on a wet window.

WINDSHIELD WIPER MOTOR

Removal & Installation

Remove wiper arm assemblies by lifting blades off windshield and pulling out tab that locks blade in up position. Remove cowl trim panel. Disconnect washer hose. Remove cowl mounting bracket attaching nuts and pivot pin screws. Disconnect wiring harness and remove wiper motor. To install, reverse removal procedure.

WIRING DIAGRAM SYMBOLS

1988 Jeep Cherokee

WIRING DIAGRAMS
How To Use The Wiring Diagrams

WIRING DIAGRAMS

INTRODUCTION

The wiring diagrams and technical service bulletins, containing wiring diagram changes, are obtained from the domestic and import manufacturers. These are checked for accuracy and are all redrawn into a consistent format for easy use.

All diagrams are arranged with the front of the vehicle at the left side of the first page and the rear of the vehicle at the right side of the last page. Accessories are shown near the end of the diagram.

Components are shown in their approximate location on the vehicle. Due to the constantly increasing number of components on vehicles today, it is impossible to show exact locations.

In the past, when cars were simpler, diagrams were simpler. All components were connected by wires, and diagrams seldom exceeded 4 pages in length. Today some wiring diagrams require more than 16 pages. It would be impractical to expect a service technician to trace a wire from page 1 across every page to page 16.

Removing some of the wiring maze reduces eyestrain and time wasted searching across several pages. Today, the majority of diagrams now follow a much improved format, which permits space for internal switch details and connector shapes.

Any wires that don't connect directly to their components are identified on the diagram to indicate where they go. There is a legend on the first page of each diagram, detailing component location. It refers you to sub-systems, using grid NUMBERS at the top and bottom of the page and grid LETTERS on each side. This grid system works in a manner similar to that of a road map.

HOW TO USE THE WIRING DIAGRAMS

1) On the first page of the diagram, you will find a listing of major electrical components or systems. Locate the specific component or system you wish to trace. A grid number and letter will follow the component's name.

2) Use the grid NUMBERS (arranged horizontally across the top and bottom of each page) to find the page of the wiring diagram that contains the component you're seeking. When you reach this page, use the grid LETTERS on the side of the page to determine the component's vertical location.

3) Locate the circuit you need to service. The internals are shown for switches and relays to assist you in understanding how the circuit operates.

NOTE: In some of the newer wiring diagram articles in this product, there is a Legend for the wiring diagrams that has been created to make locating components easier. For these articles, there will be a COMPONENT LOCATION MENU title in the article main menu. These articles will also have the original legend available on the first graphic.

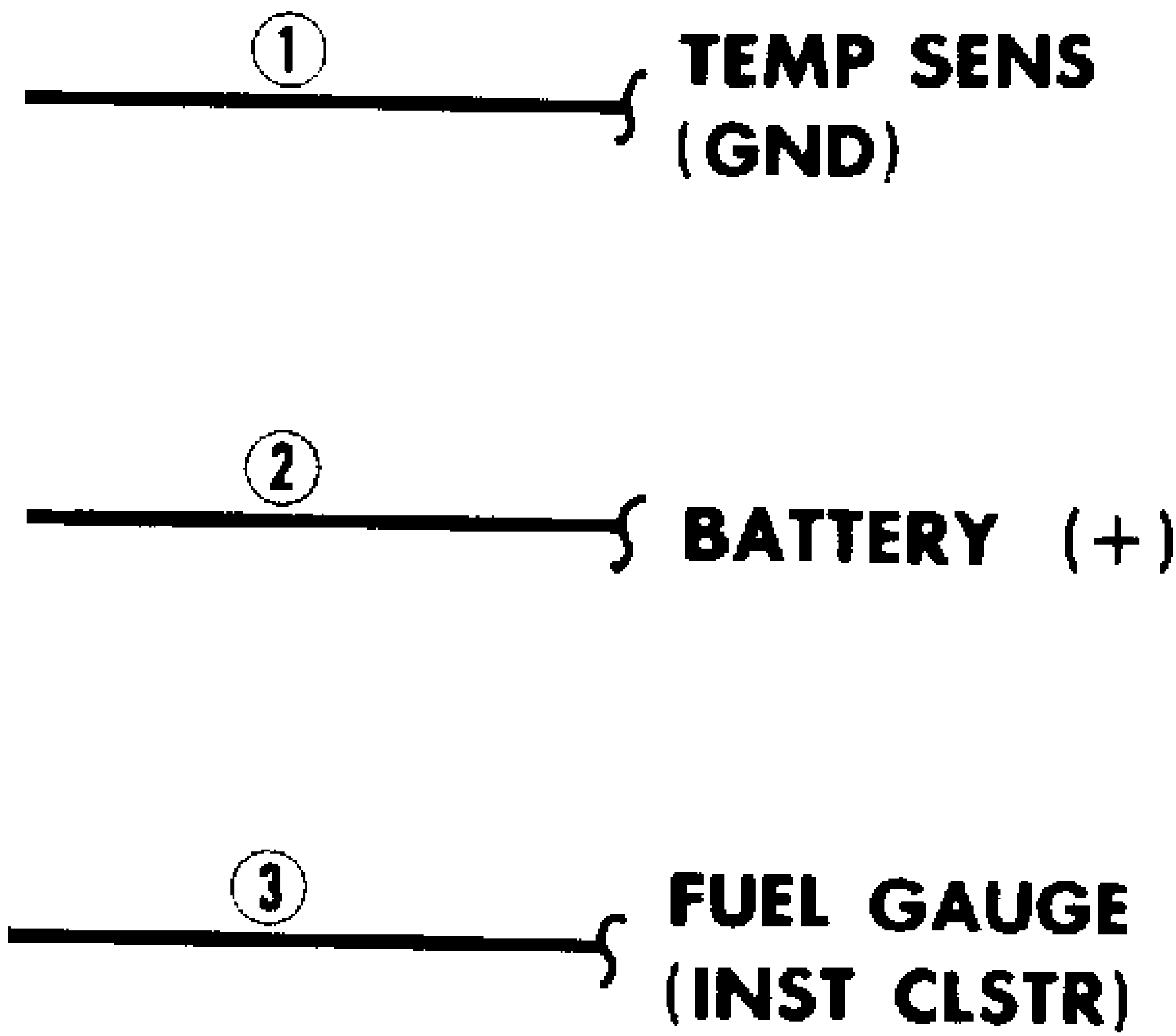


Fig. 1: Identifying Tie-Off Symbols

4) If the wires are not drawn all the way to another component (across several pages), a reference will tell you their final destination.

5) Again, use the legend on the first page of the wiring diagram to determine the grid number and letter of the referenced component. You can then turn directly to it without tracing wires across several pages.

6) The symbols shown in Fig. 1 are called tie-offs. The first tie-off shown indicates that the circuit goes to the temperature sensor, and is also a ground circuit.

7) The second symbol indicates that the circuit goes to a battery positive parallel circuit. The third symbol leads to a particular component and the location is also given.

8) The lines shown in Fig. 2 are called options. Which path or option to take depends on what engine or systems the vehicle has.

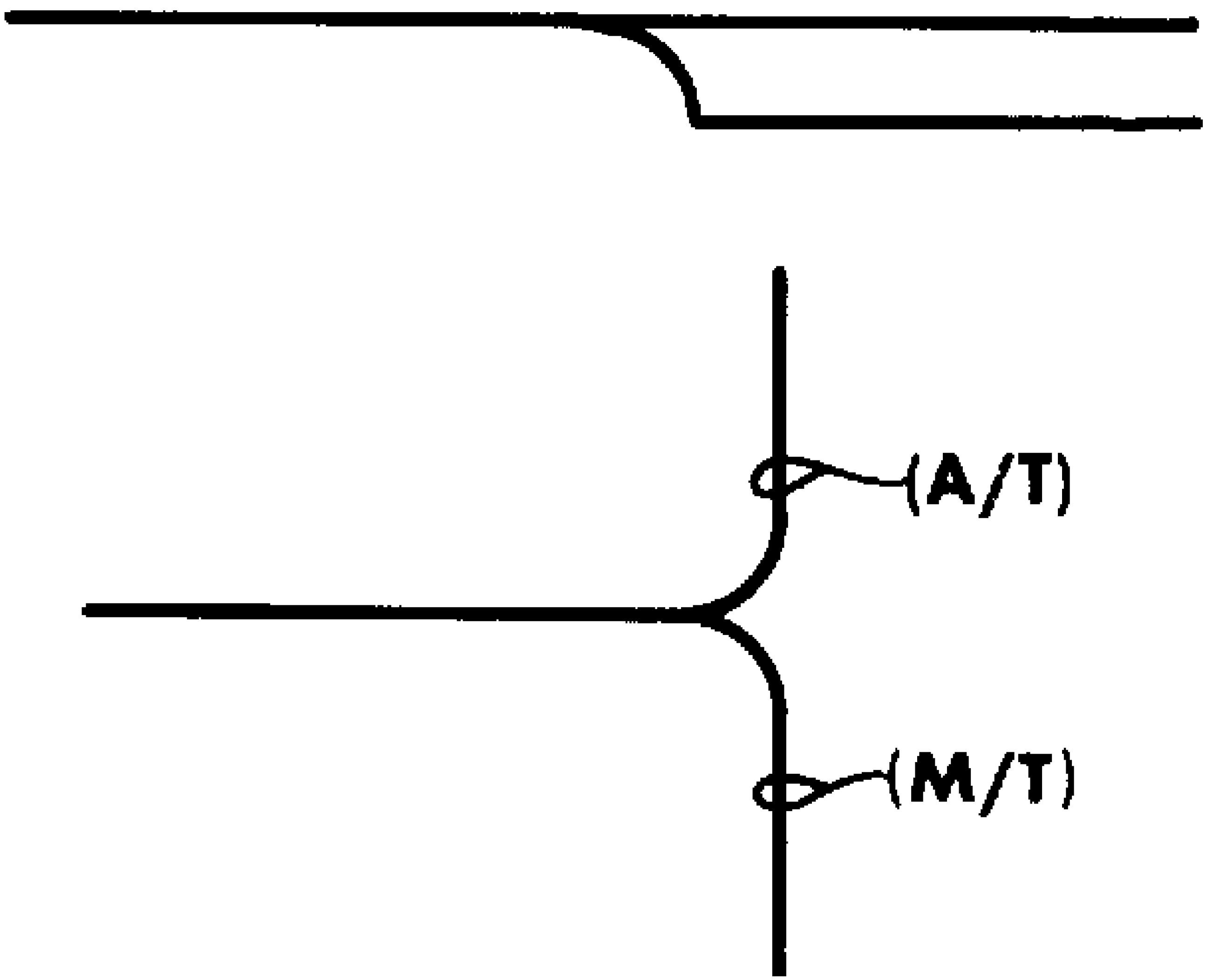


Fig. 2: Identifying Option Symbols

COLOR ABBREVIATIONS IDENTIFICATION

COLOR ABBREVIATIONS

Color	Normal	Optional
Black	BLK	BK
Blue	BLU	BU
Brown	BRN	BN
Clear	CLR	CR
Dark Blue	DK BLU	DK BU
Dark Green	DK GRN	DK GN
Green	GRN	GN
Gray	GRY	GY
Light Blue	LT BLU	LT BU
Light Green	LT GRN	LT GN
Orange	ORG	OG
Pink	PNK	PK
Purple	PPL	PL
Red	RED	RD
Tan	TAN	TN

Voilet	VIO	VI
White	WHT	WT
Yellow	YEL	YL

WIRING DIAGRAM SYMBOL IDENTIFICATION

NOTE: Standard wiring symbols are used on diagrams. The list below will help clarify any symbols that are not easily understood at a glance. Most components are labeled "Motor", "Switch" or "Relay" in addition to being drawn with the standard symbol.

WIRING DIAGRAM SYMBOLS

Views of the symbols used in the WIRING DIAGRAM articles are in the following graphics. See Figs. 3 through 25.

Fig. 3: Circuit Breaker

Fig. 4: Coil (Internal)

Fig. 5: Connector

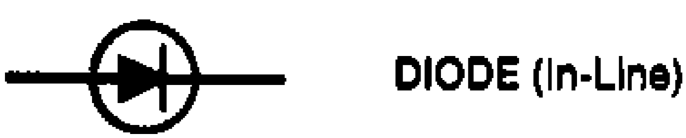


Fig. 6: Diode (In-Line)

Fig. 7: Diode (Internal)

Fig. 8: Diode (Light Emitting)

Fig. 9: Defogger Grid

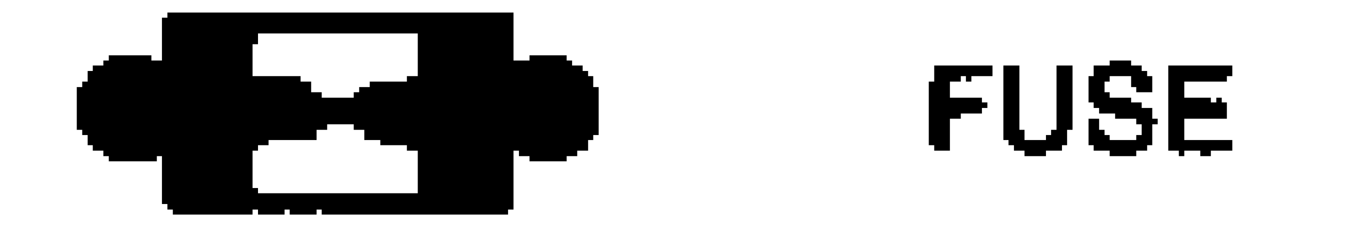


Fig. 10: Fuse

Fig. 11: Fusible Link

Fig. 12: Ground

Fig. 13: Glow Plug Resistor (In-Line) or Mirror Heater

Fig. 14: Injector (Diesel) or Photocell (Gasoline)

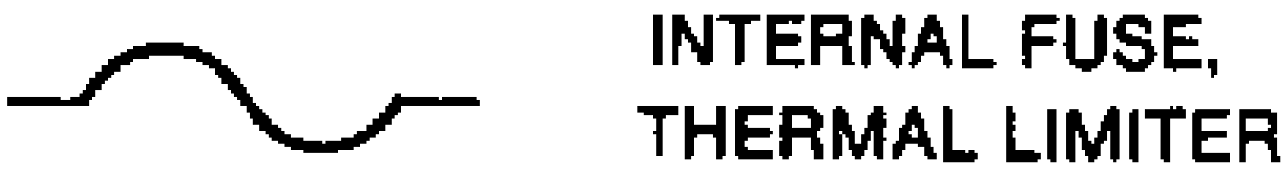


Fig. 15: Internal Fuse, Thermal Limiter

Fig. 16: Lamp (Dual Element)

Fig. 17: Lamp (Single Element)

Fig. 18: Motor

Fig. 19: Resistor (Internal)

Fig. 20: Sensor, Thermistor

Fig. 21: Solenoid

Fig. 22: Solid State Device, Transistor

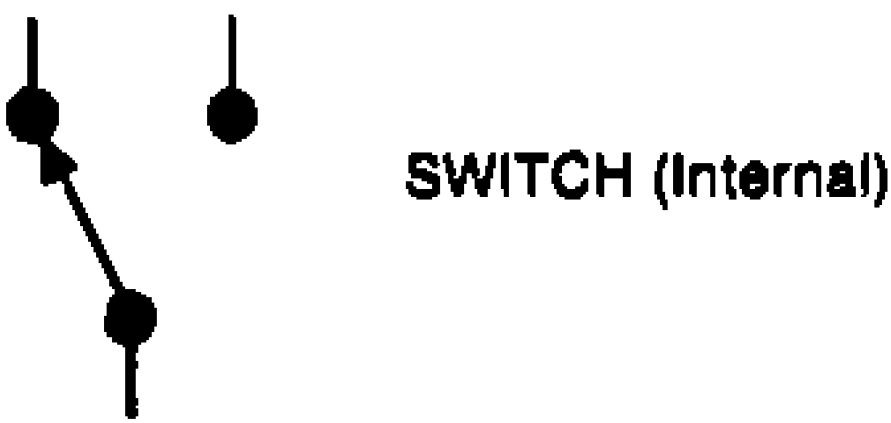
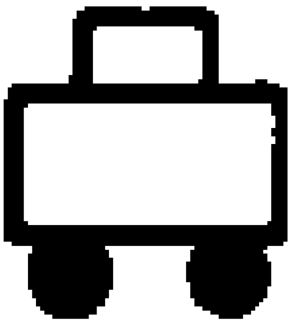


Fig. 23: Switch (Internal)



TWO PIN SWITCH

Fig. 24: Two Pin Switch

VARIABLE RESISTOR OR POTENTIOMETER

Fig. 25: Variable Resistor or Potentiometer

WIRING DIAGRAMS

1988 Jeep Cherokee

1988 Wiring Diagrams
Jeep

Cherokee & Wagoneer

IDENTIFICATION

COMPONENT LOCATION MENU

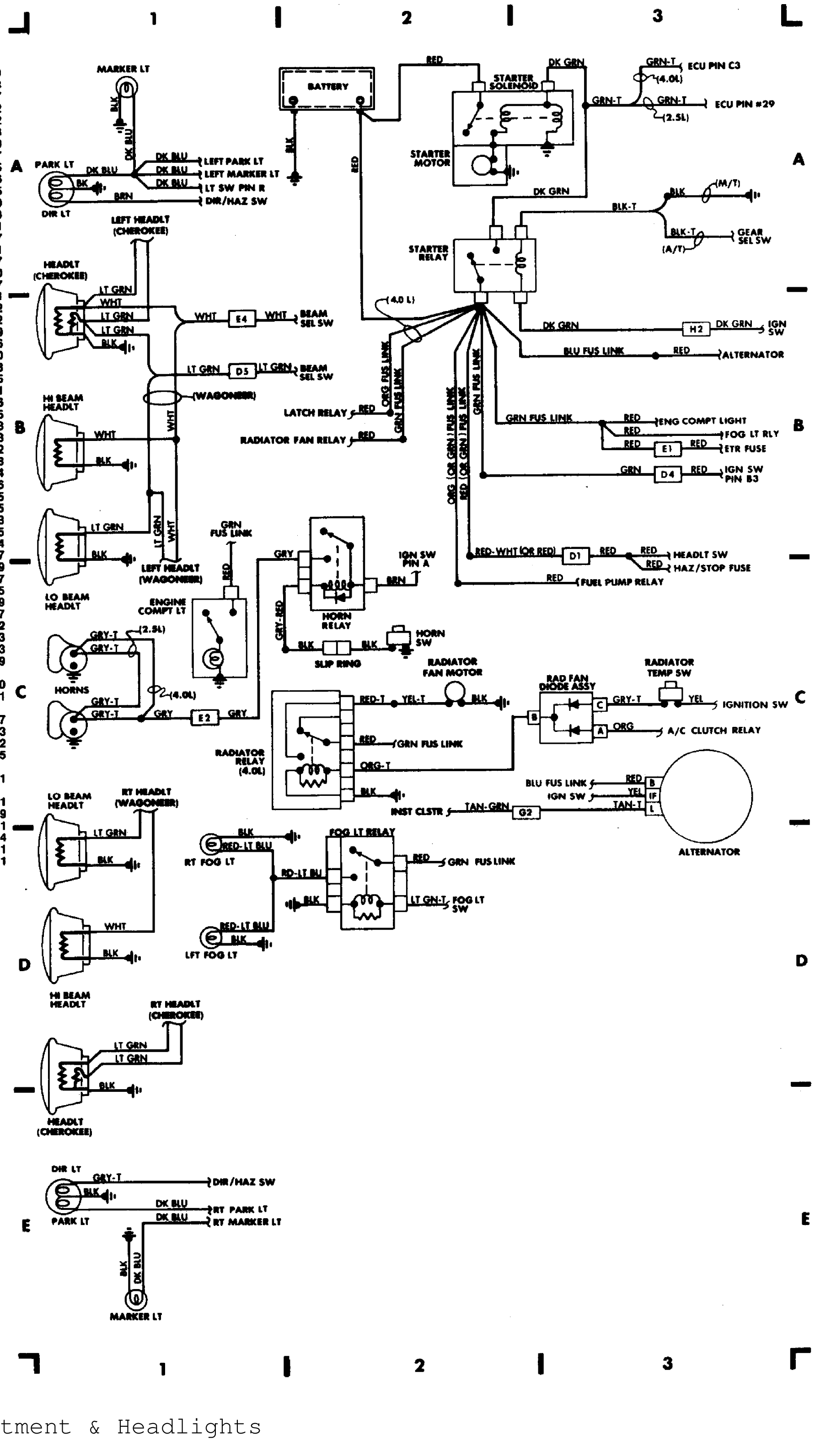
COMPONENT LOCATIONS TABLE

Component	Figure No. (Location)
A/C & Htr Systems	5 (A-D 16-19)
Alternator	1 (C 3)
Audio Alarm Module	7 (D 27)
Back-Up Lt Sw (M/T)	4 (D 12)
Battery	1 (A 2)
Beam Sel Sw	6 (E 23)
Brake Warning Sw	6 (C 20)
Clock	7 (E 27)
Clutch Switch	4 (E 15)
Courtesy Lights	7 (C 24-26)
Cruise Ctrl Sys	4 (E 12-15)
Diag Conn D1 (2.5L)	3 (B 9)
Diag Conn D1 (4.0L)	2 (B 4)
Diag Conn D2 (2.5L)	3 (B 11)
Diag Conn D2 (4.0L)	2 (B 7)
DIR Hazard Sw	6 (D-E 20-21)
Door Switches	7 (C 27)
Elect Ctrl Unit (2.5L)	3 (A 9-10)
Elect Ctrl Unit (4.0L)	2 (A 4-7)
Engine Compartment Lt	1 (C 1)
Fog Light Relay	1 (D 2)
Fog Light Sw	6 (E 21-22)
Fuel Pump Rly (2.5L)	3 (C 9)
Fuel Pump Rly (4.0L)	2 (E 5-6)
Fuel Tank Unit	6 (B 20)
Fus Links	1 (B 2-3)
Fuse Block	4 (B-D 12-15)
4WD Switch	6 (C 20, D 21)
Gear Sel Sw	5 (C 16)
Glove Box Light	7 (C 25)
Headlight Delay Module	6 (E 23)
Headlight Switch	6 (D 22-23)
Horn Relay	1 (C 2)
Ignition Ctrl Mod (2.5L)	3 (B-C 8)
Ignition Ctrl Module (4.0L)	2 (E 4)
Ignition Key Warn Sw	7 (D 26)
Ignition Switch	4 (A 12-15)
Illum Lights	7 (C-D 24-25)
Instrument Cluster	6 (A-C 22-23)
Keyless Entry Module	7 (B 24-25)
Latch Rly (B+) (4.0L)	2 (B-C 4)
Power Antenna Rly	7 (D-E 27)
Power/Comfort Sw	5 (D 19)
Power Door Lock Sys	7 (A-C 24-27)
Power Mirror Sw	7 (D-E 24-25)
Power Seat Sw	8 (A-B 28-29)

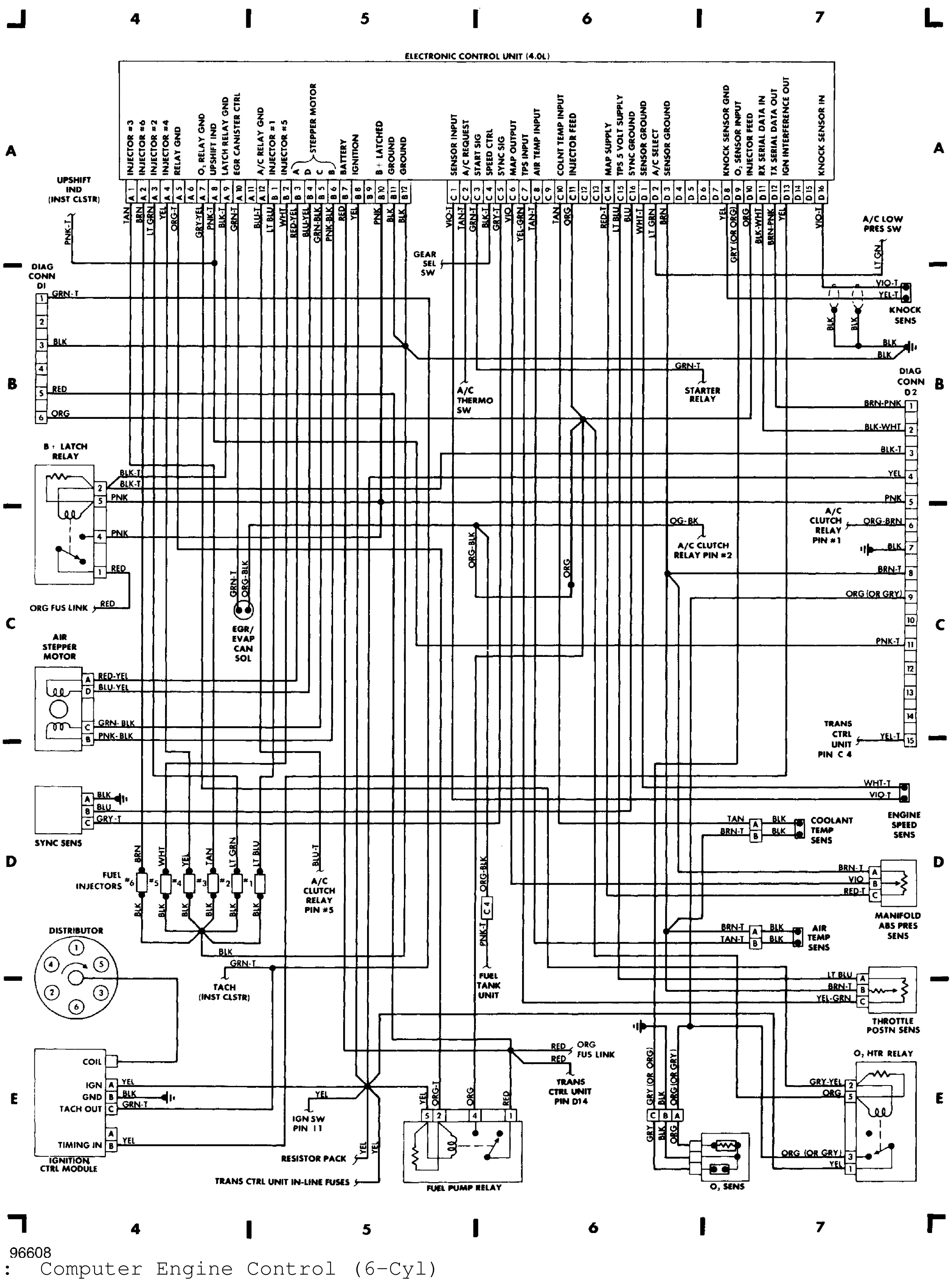
WIRING DIAGRAMS

COMPONENT LOCATOR:

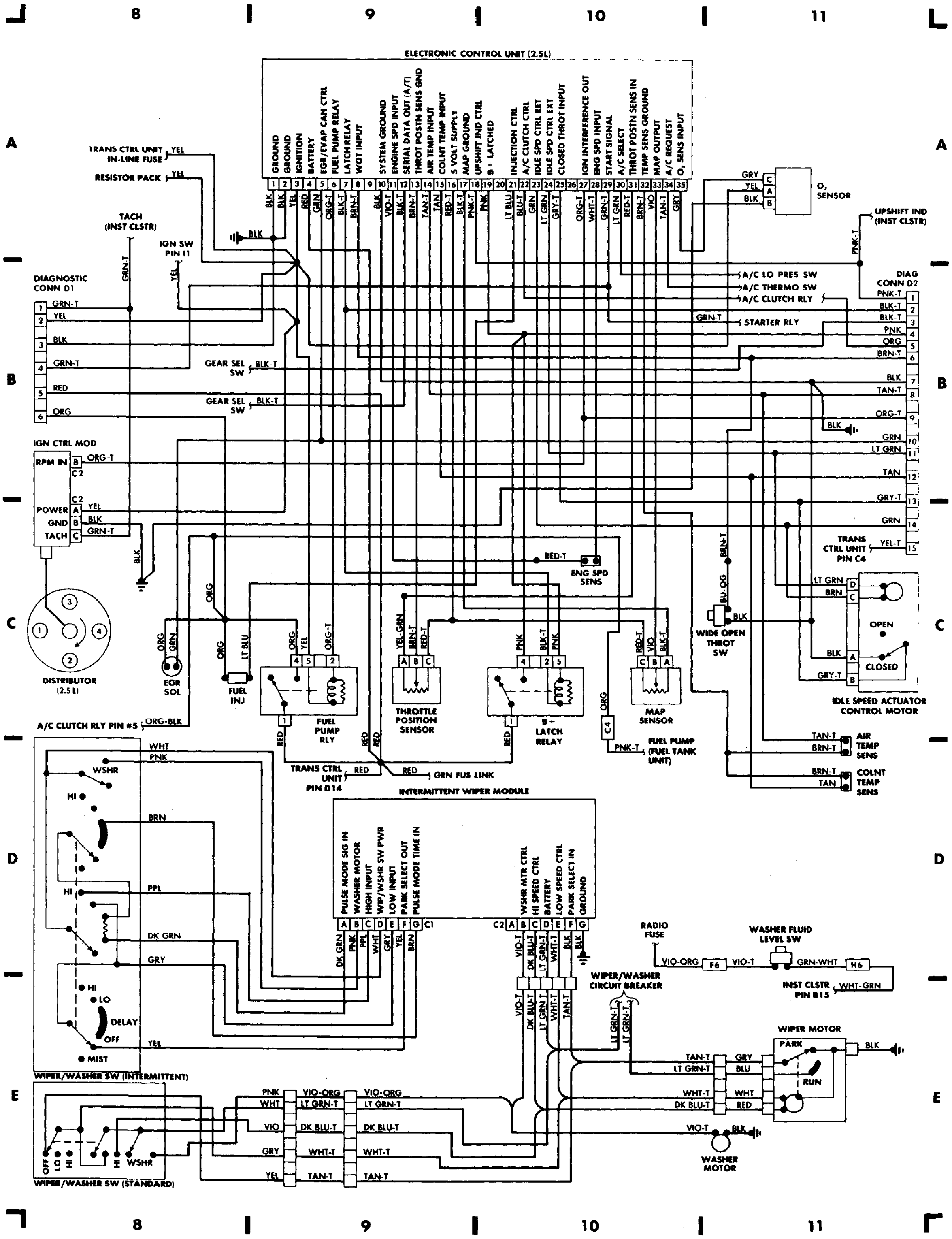
A/C & HTR SYSTEMS	A-D 16-19
ALTERNATOR	C 3
AUDIO ALARM MODULE	D 27
BACK-UP LT SW (M/T)	D 12
BATTERY	A 2
BEAM SEL SW	E 23
BRAKE WARNING SW	C 20
CLOCK	E 27
CLUTCH SWITCH	E 15
COURTESY LIGHTS	C 24-26
CRUISE CTRL SYS	E 12-15
DIAG CONN D1 (2.5L)	B 9
DIAG CONN D1 (4.0L)	B 4
DIAG CONN D2 (2.5L)	B 11
DIAG CONN D2 (4.0L)	B 7
DIR HAZARD SW	D-E 20-21
DOOR SWITCHES	C 27
ELECT CTRL UNIT (2.5L)	A 9-10
ELECT CTRL UNIT (4.0L)	A 4-7
ENGINE COMPARTMENT LT	C 1
FOG LIGHT RELAY	D 2
FOG LIGHT SW	E 21-22
FUEL PUMP RLY (2.5L)	C 9
FUEL PUMP RLY (4.0L)	E 5-6
FUEL TANK UNIT	B 20
FUS LINKS	B 2-3
FUSE BLOCK	B-D 12-15
4WD SWITCH	C 20, D 21
GEAR SEL SW	C 16
GLOVE BOX LIGHT	C 25
HEADLIGHT DELAY MODULE	E 23
HEADLIGHT SWITCH	D 22-23
HORN RELAY	C 2
IGNITION CTRL MOD (2.5L)	B-C 8
IGNITION CTRL MODULE (4.0L)	E 4
IGNITION KEY WARN SW	D 26
IGNITION SWITCH	A 12-15
ILLUM LIGHTS	C-D 24-25
INSTRUMENT CLUSTER	A-C 22-23
KEYLESS ENTRY MODULE	B 24-25
LATCH RLY (B+) (4.0L)	B-C 4
POWER ANTENNA RLY	D-E 27
POWER/COMFORT SW	D 19
POWER DOOR LOCK SYS	A-C 24-27
POWER MIRROR SW	D-E 24-25
POWER SEAT SW	A-B 28-29
POWER WINDOW SYS	A-C 24-27
RADIATOR FAN RLY (4.0L)	C 1-2
RADIATOR FAN DIODE ASSY	C 3
RADIATOR TEMP SWITCH	C 3
REAR DEFOGGER UNIT	D 28-29
REAR WIPER/WASHER UNIT	B-C 29-30
RESISTOR PACK	E 21
RT FNT DOOR LOCK/WINDOW SWITCH	B 26-27
STARTER SOLENOID	A 2-3
STARTER SOLENOID RELAY	A 2
STOP LIGHT SWITCH	E 15
TRAILER TOWING HARNESS (CHEROKEE)	E 28-31
TRAILER TOWING HARNESS (WAGONEER)	A 28-31
TRANS CTRL UNIT	D-E 16-19
UPSHIFT SW (2.5L)	C 21
VANITY LIGHTS	C 24
WASHER FLUID LEVEL SW	D 11
WIPER/WASHER SYSTEM	D-E 8-11



96607
Fig. 1: Engine Compartment & Headlights

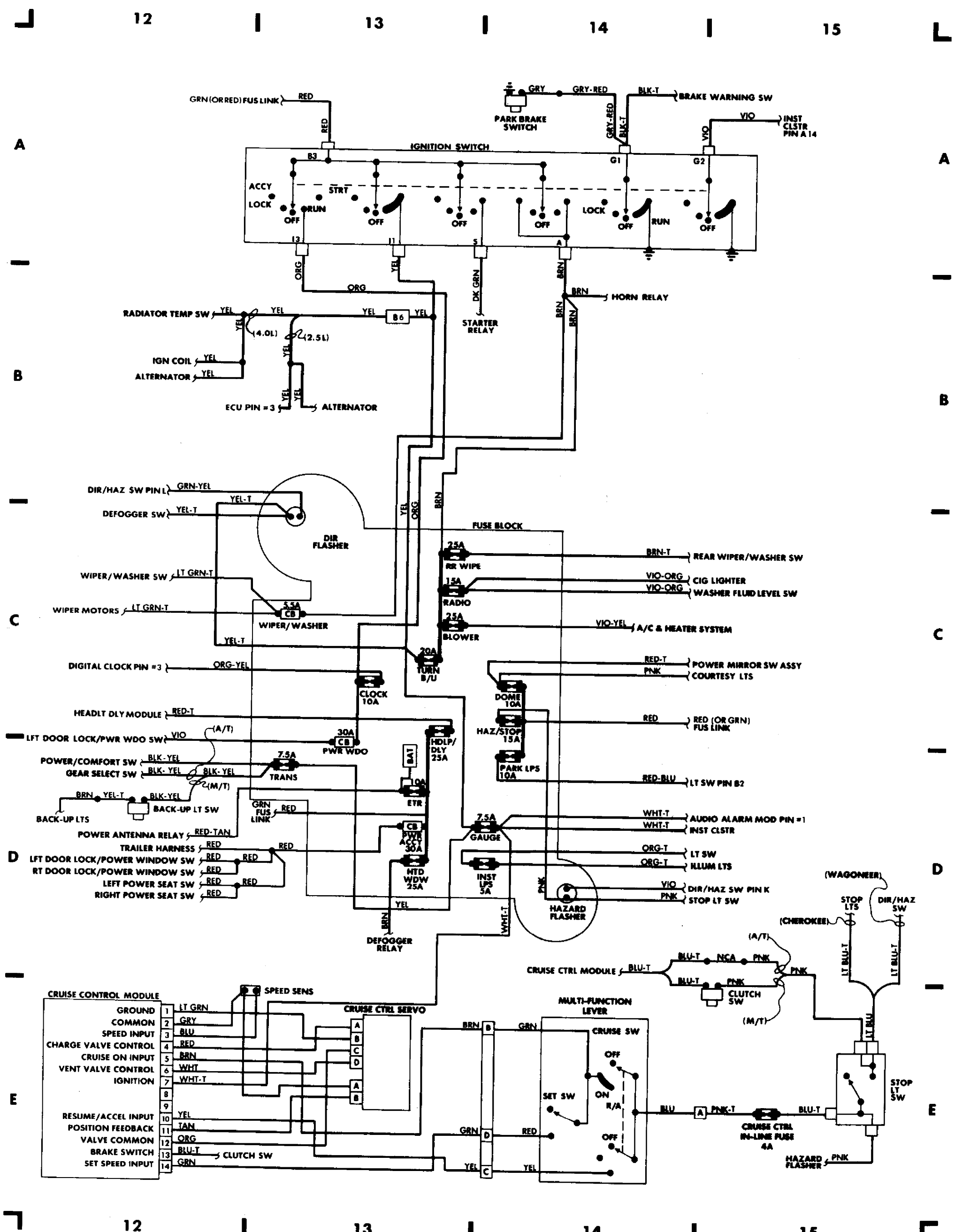


96608
Fig. 2: Computer Engine Control (6-Cyl)



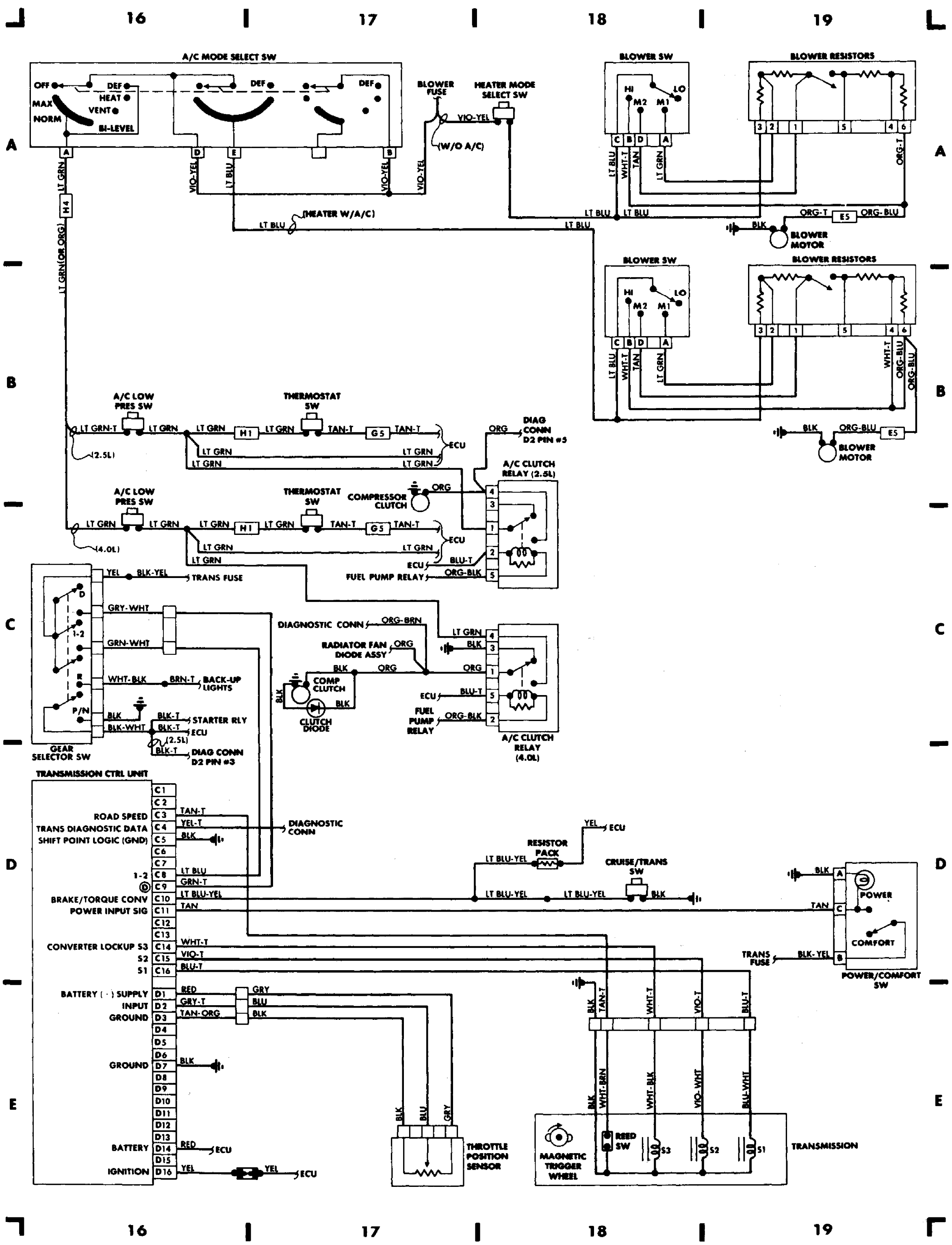
96609

Fig. 3: Computer Engine Control (4-Cyl)



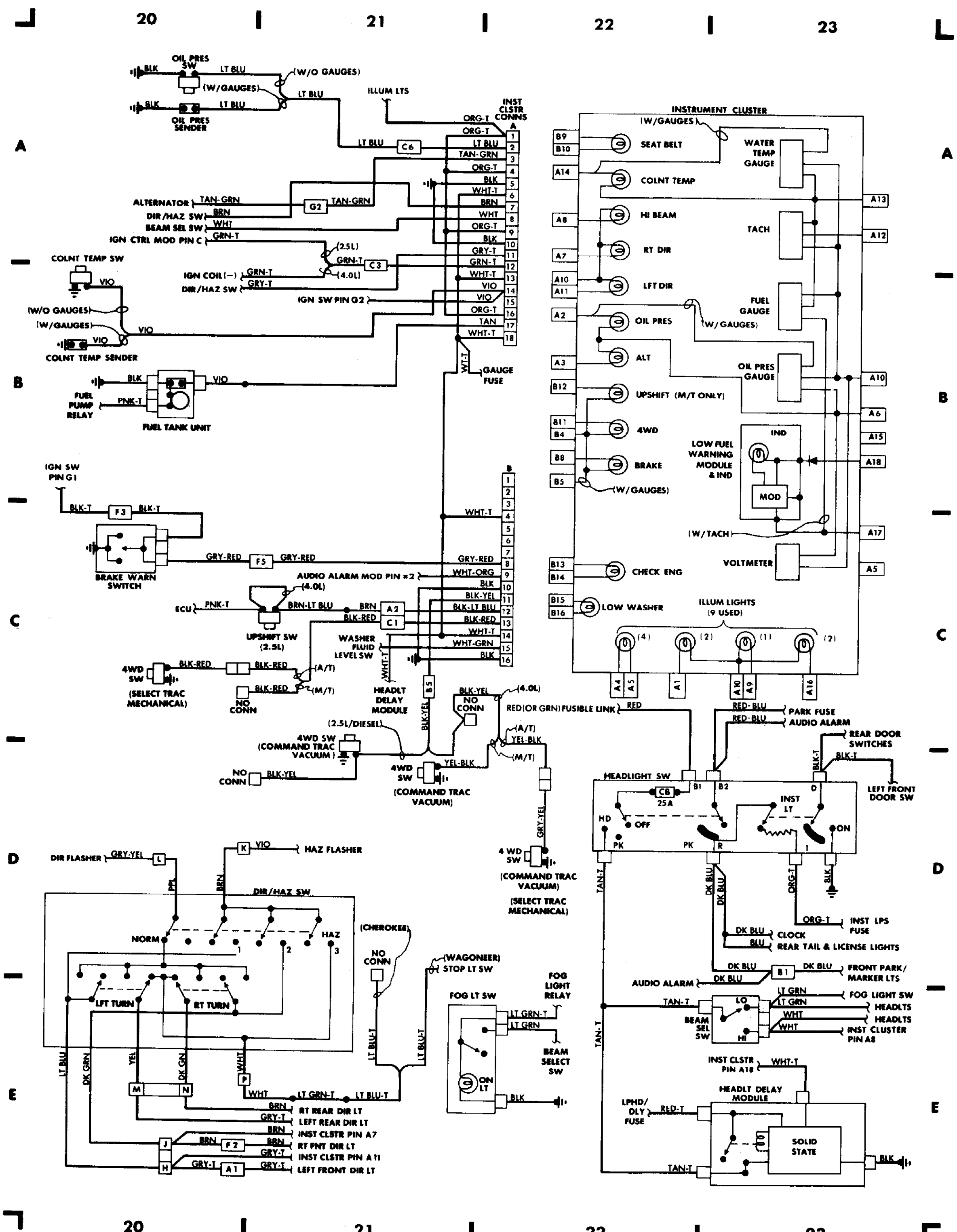
96610

Fig. 4: Fuse Block



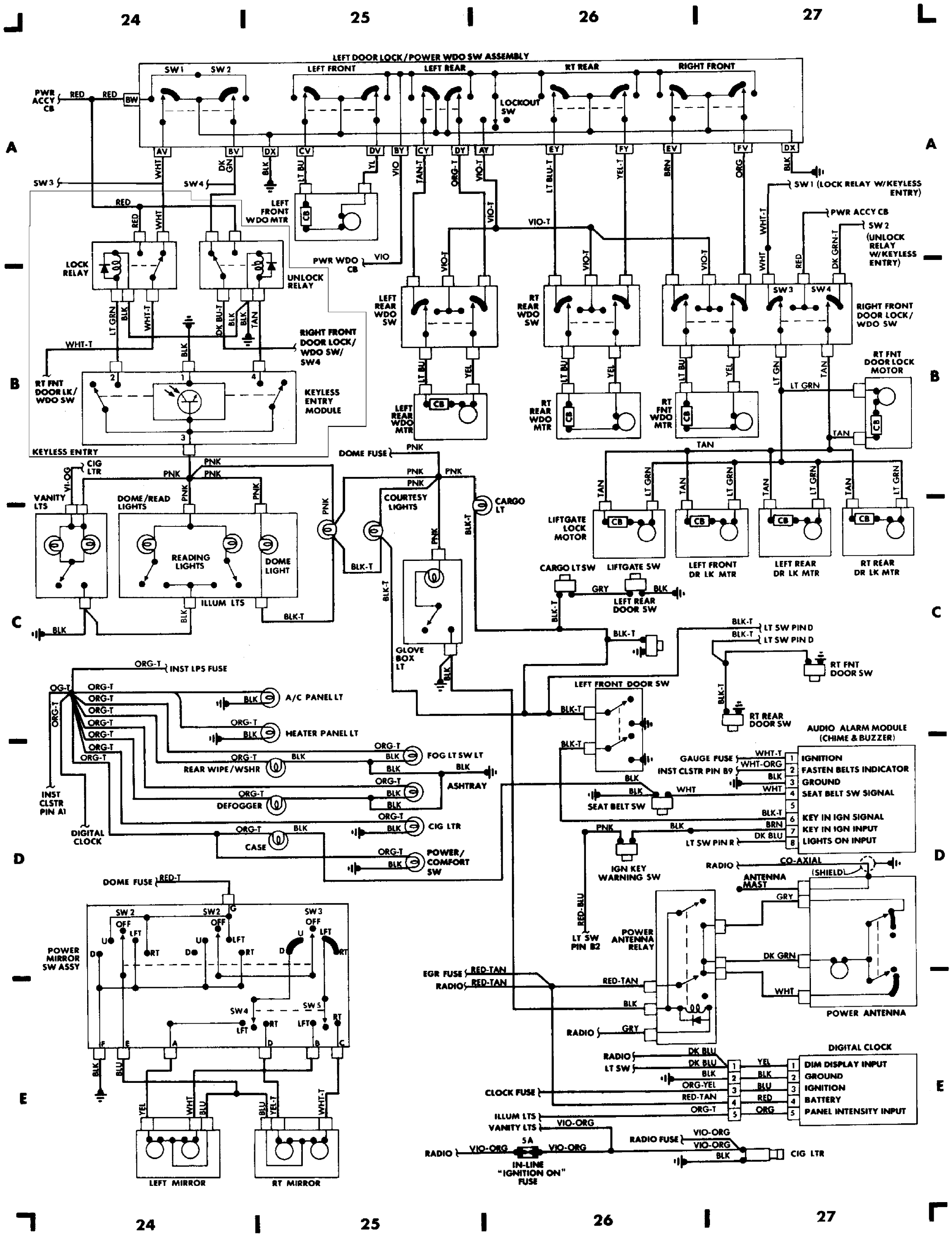
96611

Fig. 5: A/C Heating System

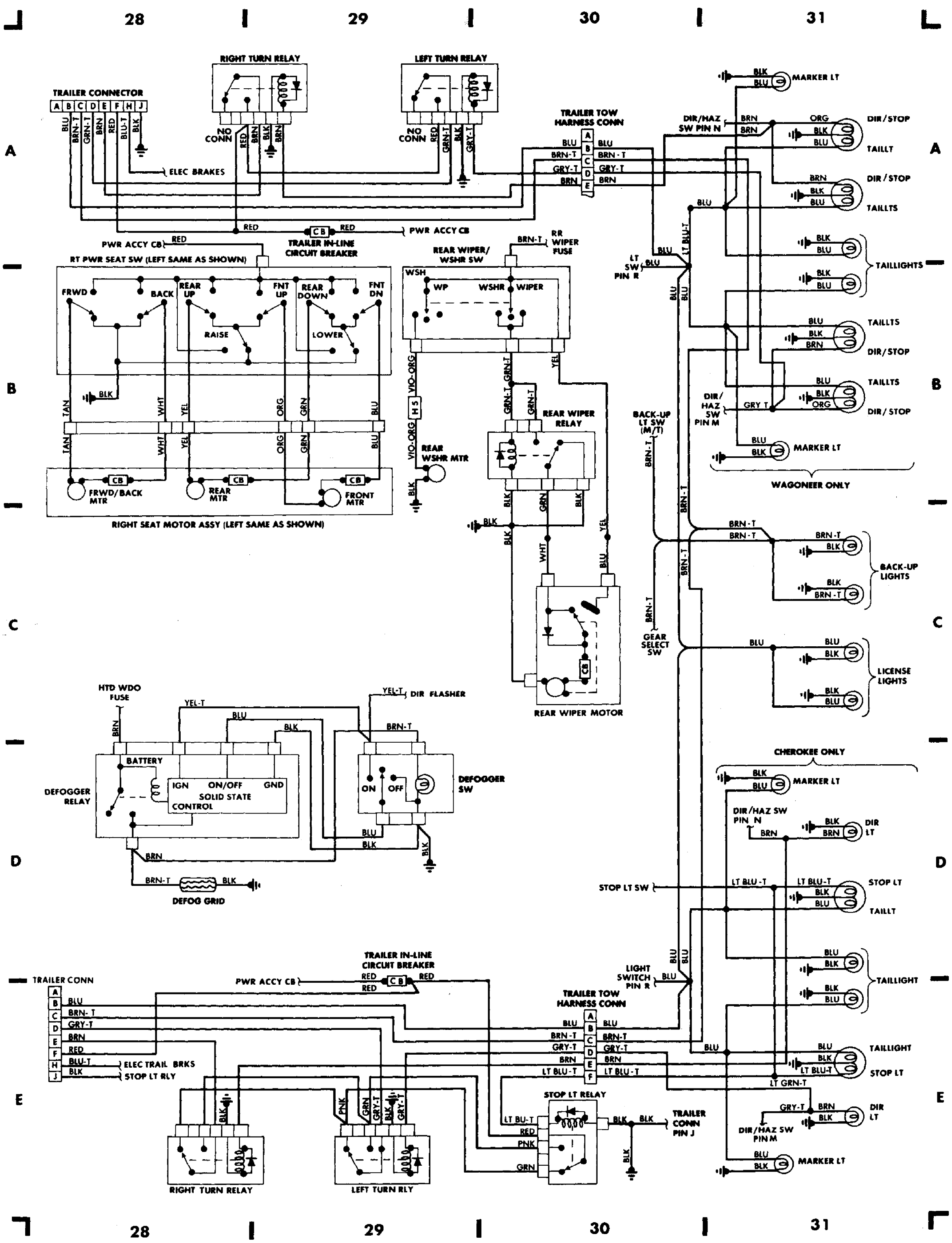


96612

Fig. 6: Instrument Panel (1 of 2)



96613
Fig. 7: Instrument Panel (2 of 2)



96614

Fig. 8: Passenger Compartment & Tail Lights